Boojum.

PORT RADIUM NORTHWEST TERRITORIES AN EVALUATION OF ENVIRONMENTAL EFFECTS OF THE URANIUM AND SILVER TAILINGS

BY

M. KALIN

INSTITUTE FOR ENVIRONMENTAL STUDIES

UNIVEHSITY OF TORONTO

NOVEMBER 1984

IN FULLFILMENT OF CONTRACT
OSG83-00074

TABLES OF CONTENTS

ACKNOWLEDGEMENTS

Foremost, it should be acknowledged that only the commitment of Brian Wilson and Dave Sutherland of the Environmental Protection Service in Yellowknife to address the environmental problems with abandoned mines in the North lead to this work. Discussion about inactive tailings sites in the Northwest Territories with the Institute for Environmental Studies started in 1981 and finally, in the summer of 1982, funds were made availabe to start the project.

I wish to thank Dave for his assistance as the Scientific Authority on the project, particularly his help during the fieldwork in 1982. I also would like to thank Johan Hellebust and Martin Smith (University of Toronto) for the generous help they offered to the project. I would also like to thank Margaret Chan for her assistance in typing the drafts and Stephen Thompson for his assistance in preparing the copy for printing.

Excellent accommodation and assistance in transportation was provided by Echo Bay Mines Ltd. in both years of the study. In addition I am greatful for many useful discussions with R. Bennett, G. Karklin, J. Zigarlick Sr. and L. Miner about the operation of the silver mine and the history of the site.

The bits and pieces of information provided with the help of oldtimers C. Lendrum, A. Dory (AECB) and E. Joe (E.M.&R) gave a rounded picture of the history of the site. I thank all of them for their time and patience required to arrive at the history of wastes at Port Radium.

The project received financial support from Environmental Protection Service, Ye1lowknife, Environment Canada, Edmonton, Department of Indian and Northern Affairs Canada, National Health and Welfare, Fisheries and Oceans Canada and the Government of the Northwest Territories, Departments of Justice and Public Services and Renewable Resources.

The role of these agencies in providing funding and constructive criticism of the report through the Intergovernmental Committee on Environmental Contaminatints is gratefully acknowledged.

SUMMARY

Of primary importance in this work was the identification of the locations of uranium mill tailings, or any wastes containing long-lived radionuclides around Port Radium. On the peninsula, depressions were utilized initially for waste disposal during the uranium mining era, as for example Radium Lake and Murphy Lake. Radium Lake has been covered for some time with waste rock and overburden. Since the closure of the silver mine in May 1982, Echo Bay Mines Ltd. has undertaken the covering of most of Murphy Lake with waste rock. The West Adit Tailings Area was the only area identified on land where wastes from the uranium milling operation have collected but remain uncovered. Minor amounts of uranium tailings are found on the rock slope above West Adit and in the spillway of Murphy Creek. About one million tons of uranium mill tailings have been discharged into Murphy Bay, via Murphy Creek and down the slope of West Adit.

Though the uranium wastes had a weak acid generation potential, acid generation was evident only in the wastes which remain deposited on land. The tailings samples recovered from Murphy Bay were alkaline. Based on the parameters considered in this study, deep lake disposal appears, in retrospect, to have been an acceptable solution for uranium tailings disposal at Port Radium. On the other hand, the small amount of tailings and wastes in the West Adit Area indicated the problematic nature of terrestrial disposal. It is concluded that, in the vicinity of Port Radium, the water quality has not been affected by the uranium and radium tailings discharged from 1933 to 1960.

The Silver Point Tailings Area was originally a small bay created by the construction of a causeway to Silver Island. This bay received the radium tailings which were later dredged for uranium extraction, then the bay was refilled with silver tailings between 1964 and 1975. This tailings area and Garbage Lake, which was used initially as a garbage dump, then as a tailings disposal site since 1975, are the only silver tailings sites on land.

The Silver Point tailings, which form beaches on Cobalt Channel, and Garbage Lake, with silver tailings in a well confined basin, were not apparent sources of contamination to Great Bear Lake in their existing condition. Water overlaying the tailings in Garbage Lake prevents aerial dispersal of tailings, but more importantly, the thermal stratification of the water inhibits potential

migration of contaminants into the surface water. The only apparent effect of the effluent from Garbage Lake was the algal bloom in Bear Bay. The Silver Point Tailings Area had mainly coarse tailings on the surface, hence wind dispersal has been minimized. A waste rock cover over the area is not recommended, as contamination may result from increased pressure on the waterlogged area, causing extrusion of contaminated porewater into Great Bear Lake.

The alkaline silver tailings in LaBine Bay and Cobalt Channel did not produce acid, nor did they contain high concentrations of radionuclides and heavy metals. Since the solubility of most heavy metals and radionuclides in alkaline systems is low, changes in the water quality are unlikely to occur. It is concluded that the water quality of Great Bear Lake has not been affected by discharges of either the uranium or the silver tailings. Weathering of the waste rock produced localized increases in metal concentrations in the water, but dilution had minimized the extent of the area affected.

Two tons of pitchblende were shipped to Madame Curie for her studies on radiation which lead to a Nobel Prize and later uranium was shipped to the Manhattan project.

In conclusion, the assessment of the environmental effects of the waste sites on the peninsula and on the surrounding waters revealled that, although 1.5 million tons of silver and uranium tailings are in close contact with Great Bear Lake water, environmental problems were not evident.

LIST OF MAPS, TABLES, FIGURES AND APPENDICES

MAPS Page

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1. Introduction

In the early 1930's, Gilbert LaBine discovered an ore body on a small peninsula on the eastern shores of Great Bear Lake. Radium, uranium and silver were the principal ores mined in Port Radium between 1933 and May 1982 when the last ton of silver ore was mined by Echo Bay Mines Ltd. Underground workings were closed, and mine and mill buildings are being dismantled presently as part of the general restoration of the site.

The Environmental Protection Service (EPS) carried out an initial survey of radionuclide and metal concentrations in sediments around the Port Radium peninsula in 1978. Monitoring of Great Bear Lake water quality was also carried out in March of 1982 by Indian and Northern Affairs Canada. In 1982, EPS contracted with the University of Toronto to assess the condition of the waste sites at Port Radium. After an initial survey, the locations and physical and chemical characteristics of the wastes sites were described in detail, as well as the occurrences of indigenous vegetation which had invaded the waste sites.

Water sampling in 1982 identified the potential for contamination from some waste areas during spring run-off. During the dry summer months, however, no contamination of Great Bear Lake from the tailings areas was observed. In 1983, the question of contamination from the waste area during runoff was addressed with a more intensive water sampling program.

1.2 Objectives of the Study

The objectives of the work at Port Radium were to determine the distribution of the uranium mill tailings on the peninsula and in the surrounding waters. The wastes from the radium and uranium extraction operations were compared to the silver tailings and both are described to provide an assessment of:

1) physical and chemical characteristics of the waste sites, their effluents and the water in the vicinity of the peninsula; and

2) the environmental implications of the mining wastes on the peninsula and in the surrounding waters.

1.3. Site History And Description

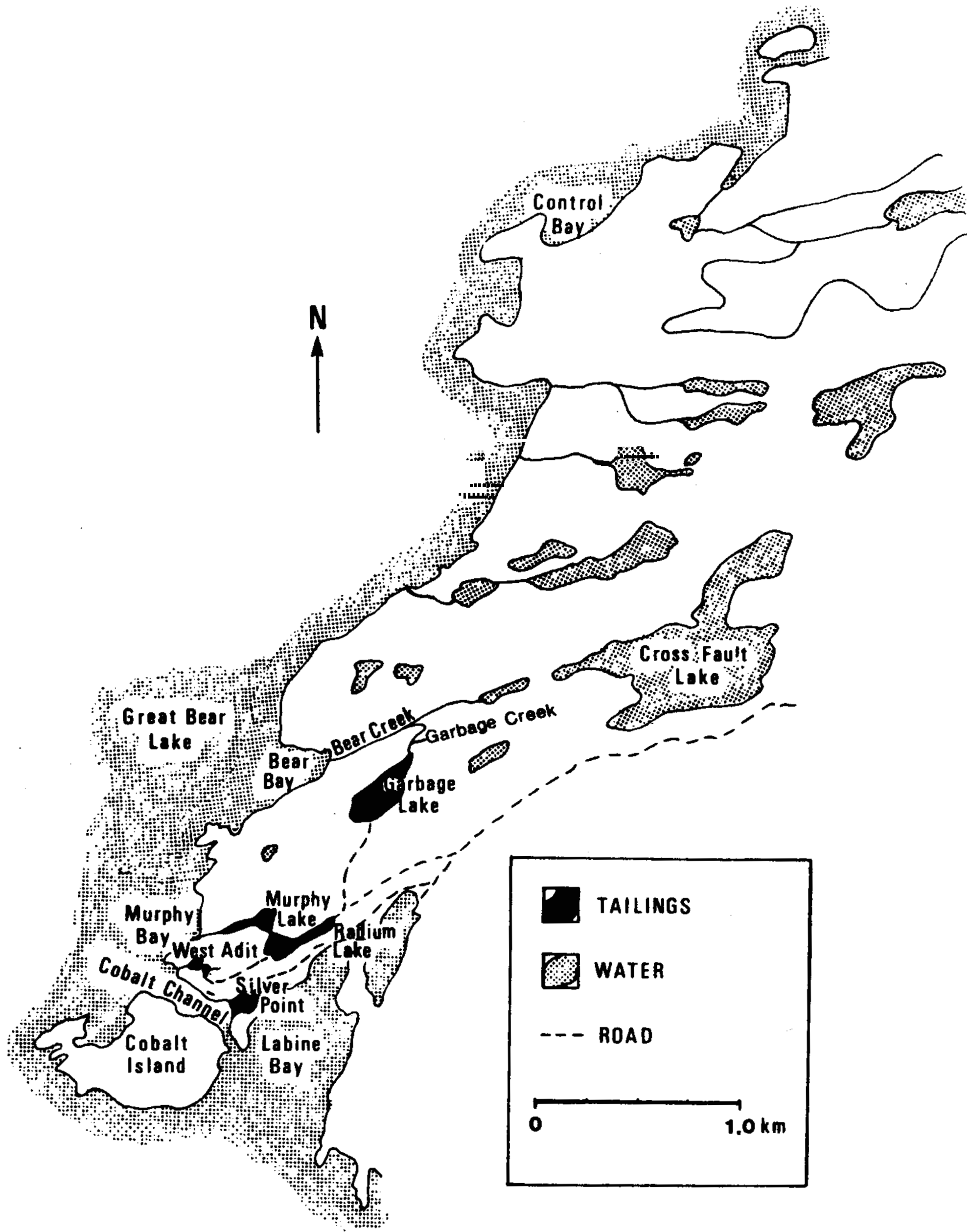
1.3.1 Site History

One of the first pitchblende ore bodies in the world was discovered in the early 1930's by Gilbert La Bine on the Port Radium peninsula. In 1933, Eldorado Mining and Refining Ltd. began a radium extraction operation at a rate of 50 tons a day, using a gravity plant to produce a concentrate from mined ore. Uranium at that time was only a byproduct, and was discarded with the radium tailings into a bay which had been created by the construction of a causeway to Silver Island (now called Silver Point)(Map 1).

Leaching techniques for the extraction of uranium were developed between 1947 and 1949. The first sulfuric acid leach plant in Canada began uranium extraction at Port Radium in April 1952. In addition to ore from the milling operation, the radium tailings previously discarded into the bay were dredged to be used as feed for the leach plant (Hoffman, 1957). Between 1952 and 1960, approximately 340,000 tons of tailings had been reclaimed from the bay (DIAND File). Griffith (1967) reported that the mill was operating at an increased capacity of 300 tons per day by April 1960. On September 16, 1960, the operation shut down due to the depletion of the ore reserve.

From the records of uranium milling, an estimated 1,000,000 tons of tailings were discarded (Wollett, 1972). Tailings were discharged into Radium Lake and Murphy Lake to create working space, but a far greater proportion of the tailings disappeared into the deep waters of Great Bear Lake near the West Adit (Map 1).

In 1964 Echo Bay Mines Ltd. began a silver extraction operation at Port Radium, re-using some of the facilities of Eldorado Mining and Refinery Ltd. Milling started in the same year at the rate of 100 tons per day, Processing ore from the new Edgar shaft (also known as Adit #3). By 1975, the capacity of the mill had increased to 150 tons per day. About 260,000 tons of ore were processed by the Echo Bay mill operation from the #3 adit (p.c., G. Karklin). The alkaline tailings, and mill process liquors were discharged into an uncontained area outside the mill, accumulating to form the Silver Point Tailings Area or flowing into Cobalt Channel (Map 1). Minewater was discharged to Labine Bay.



Map 1: **Overview *of* the waste areas on the Port Radium peninsula.**

In 1972-73, Roy and Vezina (1973) investigated mine waste management, in the Great Bear Lake area. They recommended the use of a confined basin for future tailings deposition. After consideration of several options for tailings disposal, McDonough Lake was approved as the most suitable tailings disposal site on the peninsula. The lake had been used already for some years as a garbage disposal site. It was a confined basin, large enough to hold tailings for an estimated 25 years of mine operation. At present it is commonly referred to as Garbage Lake, a suitable name since scrap metal from the Eldorado Mining and Refining Ltd. operation was deposited there (Chambers, 1973). Garbage Lake became the only tailings pond and garbage dump of the Port Radium mining town.

Between 1975 and 1982, 243,000 tons of ore were mined from the dewatered Eldorado mine (Shaft #1). The tailings and mine wastewater were treated with barium chloride and ferric sulfate to precipitate radium and arsenic respectively, then discharged into Garbage Lake. The last ton of silver ore was milled in May, 1982. It is estimated that the silver mining operation produced a total of about a half million tons of tailings.

1.3.2 Site Description

Port Radium is located on a peninsula on the eastern shores of Great Bear Lake midway along the McTavish Arm. Bathymetric maps of Great Bear Lake indicate depths of 300 to 424 m around Port Radium (Johnson, 1975). A narrow strait, Cobalt Channel, lies between the tip of the peninsula and Cobalt Island. From the channel, a steep, bare rock shoreline continues northward until becoming a pebbly beach on the Murphy Bay shore line. Bear Bay, the point at which the discharge from Garbage Lake enters Great Bear Lake, has a similar shoreline to Murphy Bay. (Map 1).

LaBine Bay is located to the east and north of Cobalt Channel. The outer part of the bay is bordered by a waste rock causeway on the north side while the southern shore of LaBine Bay is rocky. The inner part of the bay has shallow vegetated shores on the southern tip. The northern tip was used for docking aircraft and pleasure boats and for mining activities related to the #3 adit.

The four areas containing tailings are referred to as Silver Point Tailings Area, Radium and Murphy Lakes, West Adit Tailings Area and Garbage Lake (Map 1 and Plates 1-4, Appendix D).

The Silver Point tailings were deposited during the silver extraction operation. The area was later used for storage. The tailings beach along Cobalt Channel is approximately 100 m in width consisting of compacted tailings behind an embankment of waste rock.

During the extraction of uranium some tailings were discharged into Radium Lake and Murphy Lake. Both areas have since been covered by waste rock. From Murphy Lake a dry creek bed descends westward to Murphy Bay. During the uranium milling operation, tailings slurries overflowing from Murphy Lake coursed through the creek, filling the depressions with tailings.

A small depression below Shaft # 1 is referred to as the West Adit Tailings Rrea. The steep slope immediately below Shaft #1 had remnants of fine tailings, and in depressions such as the West Adit Area, coarse tailings were mixed with fines, peat and soil.

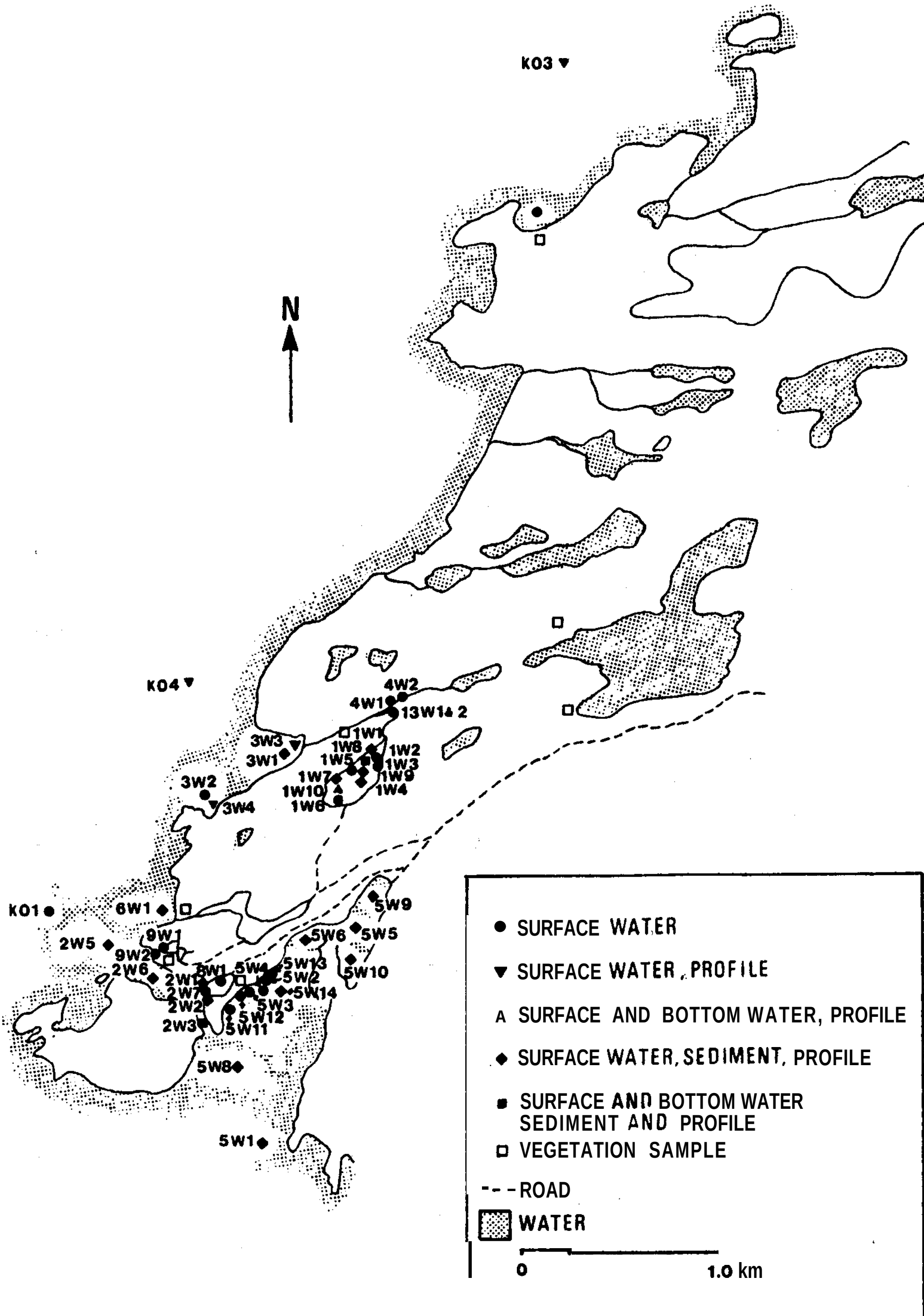
The fourth area which contains tailings is Garbage Lake. A small tailings beach is located at the southern end of the lake. The original lake level was considerably lower than at present. In the past, water or tailings slurry left Garbage Lake over a weir and entered Garbage Creek and then Bear Creek . The bed of Garbage dreek was dry in 1982 and 1983 since an overburden dam was constructed in 1982 to contain all waters from Garbage Lake. Tailings fines were found at various locations along Bear Creek.

2.0 METHODS

2.1. Field Sampling Methods

2.1.1. Water

The quality of water which was associated with tailings and sediments was of particular interest in this sampling program. Therefore, sampling station locations in the vicinity of Port Radium were determined after an initial survey was carried out of the types of bottom materials. Dissolved oxygen, temperature and conductivity profiles were determined in the water column. When stratification was evident, water from the bottom was sampled with a Van Dorn bottle, along with surface water from the top meter. Due to equipment failure in both years, sampling had to be restricted to the surface at some locations. All water sampling locations are given in Map 2.



Map 2: Water sampling locations in 1982 and 1983.

In 1982 one-litre samples of water for metal analysis were filtered (0.45 um) within 6 h of collection and acidified to pH 1 or less with concentrated nitric acid. The acidification was checked after 48h and additional acid added, if required. In 1983, 0.5 1 of water was filtered for metal analysis as before, but additional, unfiltered 0.5 1 samples were acidified for radionuclide and metal analyses.

In a waterlogged area on the Silver Point Tailings Area porewater was extracted from the tailings by driving a front-end loader back and forth in the same location several times.

Primary productivy was determined for Great Bear Lake at location 5W8 (Map 2) and in Garbage Lake (stations 1W8, 1W9 and 1W10) in June 1983. 100 ml vials were filled with surface water in several replicate sets and 25 ul (or 10 uCi) of C14 were incubated in situ for 4 h. After incubation, the water was filtered, and the filter papers were rinsed with lake water several times and then air dried. Productivity estimates were derived by subtracting dark vial counts from light vial counts.

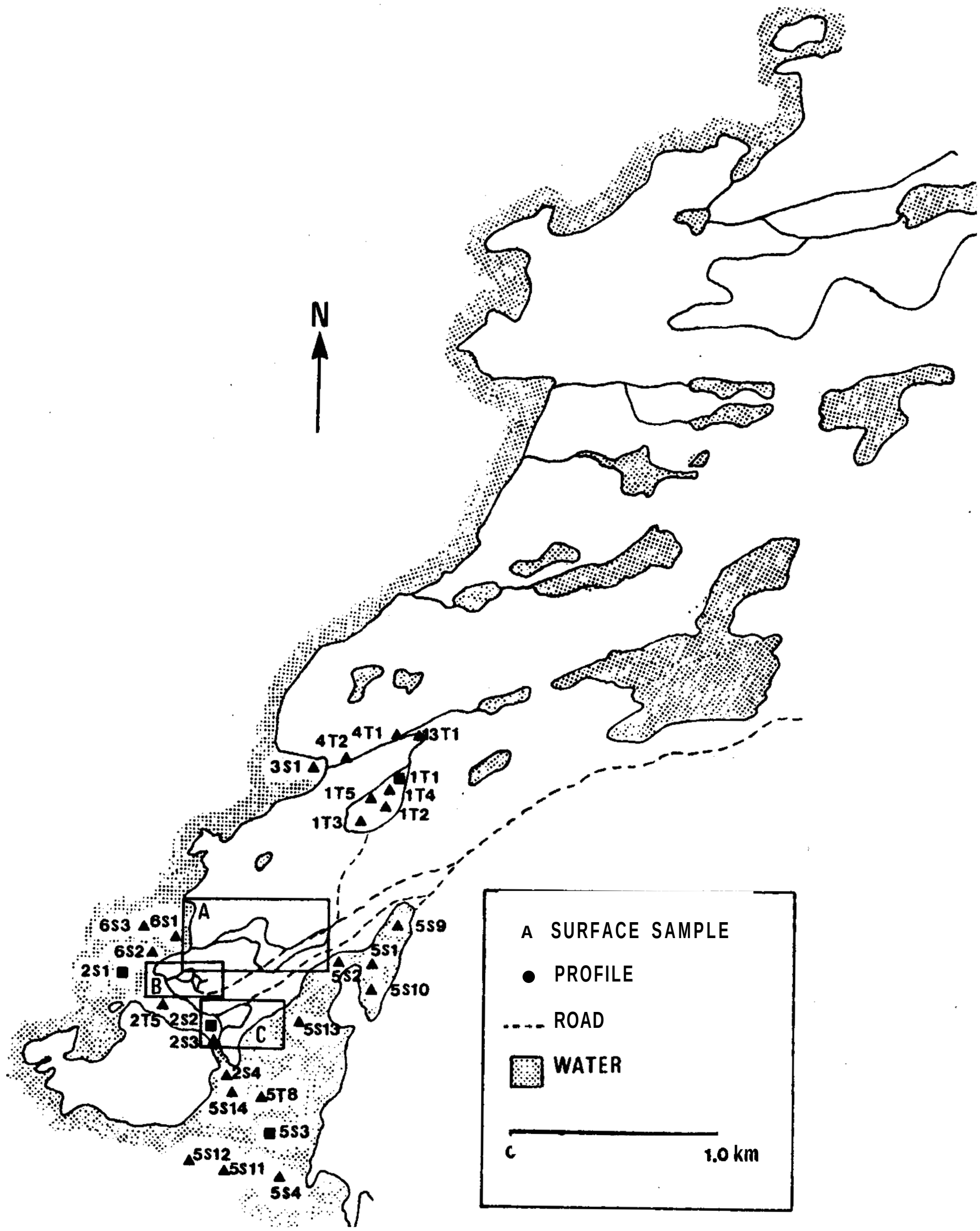
2.1.2 Sediments

Sediments were collected with an Ekman grab. Upon retrieval, the grab was placed carefully into a plastic pail, where pH, oxygen and conductivity were measured immediately. Where possible, the layers of sediments were sampled separately. The samples were frozen in plastic bags before shipment to the University of Toronto. Conductivity and pH were redetermined in the laboratory and the samples were kept frozen until further preparation proceeded. Sampling locations are shown in Map 3.

2.1.3 Tailings and Soils

Grab samples of tailings or soil were collected during the reconnaissance of the waste locations, and slurried on site (1:1 v/v) to determine pH and conductivity. These preliminary field measurements were used to determine additional sampling locations. Only samples of solids were analyzed for radionuclides in 1982 as a means of characterizing the major sources of contamination. This approach facilitated a focused water sampling program in 1983 after the potential sources of water contamination had been identified.

The solids were collected with a hand trowel and stored in plastic bags. Sampling locations of tailings and soil are depicted in Map 3 for the entire area investigated.



Map 3: Tailings, sediment and soil sampling locations on or around the Port Radium peninsula. Areas A, B, and C are shown in more detail in Map 4.

Detailed sampling locations are given for West Adit, Murphy Lake and Silver Point tailings (Map 4). The sampling consisted either of single grab samples or, if distinct strata were present, samples from each strata of the profiles.

The pH and conductivity meters were calibrated daily with buffers and standard solutions, respectively. The values of pH and conductivity reported are those determined in the laboratory based on a 1:1 (w/v) slurry prepared with distilled water. Conductivity and pH measurements in the laboratory were in good agreement with the results determined directly in the field. See Appendix B for details of the pH and conductivity determinations.

2.1.4 Vegetation

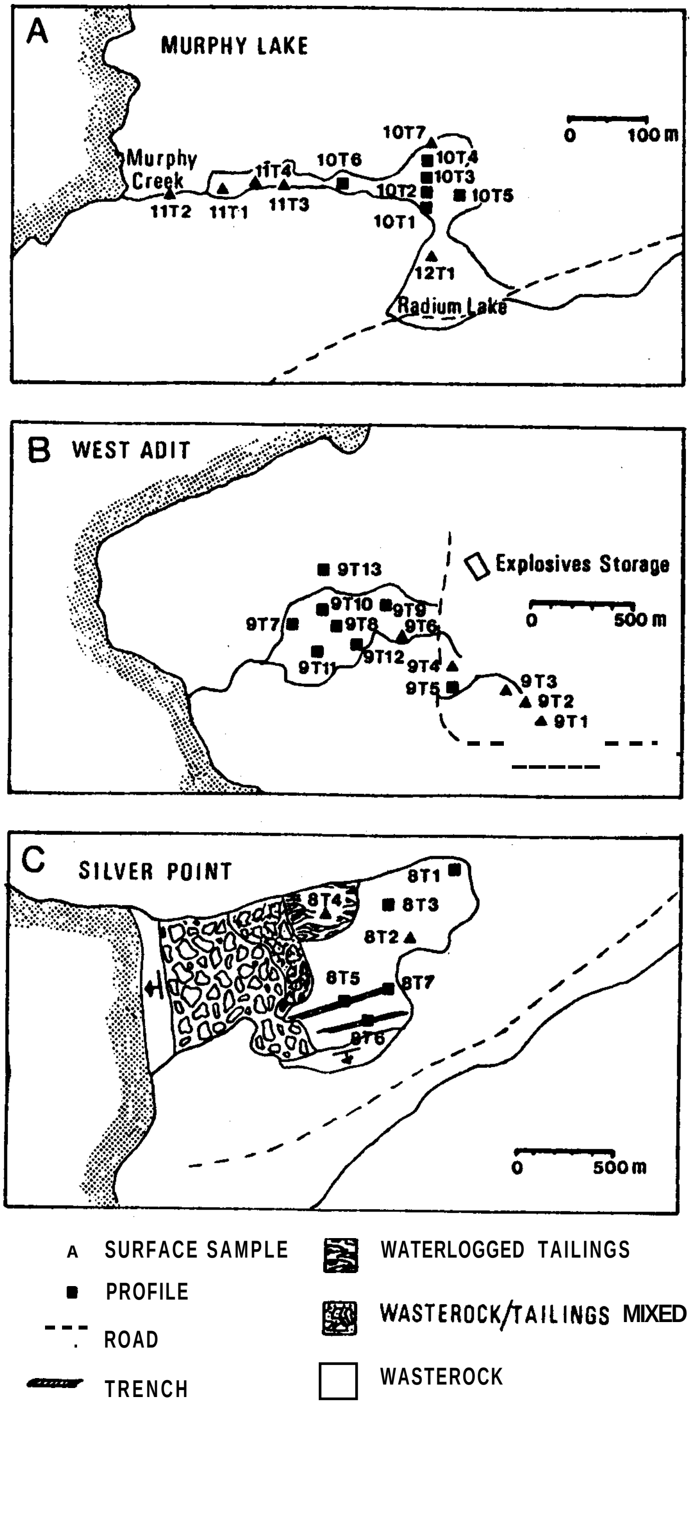
Biota living in association with the waste material were collected and identified to assess the potential for colonization of waste materials. Aquatic periphytic algae and terrestrial plants were collected in effluent creeks or on the waste material. Vascular plants were identified by C.Manville and are deposited at the Herbarium (Department of Botany, University of Toronto). Bryophytes were also collected and specimens are at the National Museum in Ottawa. The major groups of algae were identified by J.H. Hellebust (Department of Botany, University of Toronto), using samples preserved in Lugol's solution. A description of the sampling locations is presented in Appendix D.

2.2. Laboratory and Statistical Analysis

Detailed methods for the analyses outlined below are presented in Appendix B.

2.2.1 Water Analysis

All 1982 water samples were analyzed unconcentrated by ICP (Inductively Coupled Plasma Argon Spectrophotometry). Detection limits for ICP analysis of the samples are given in Appendix A along with the results. The instrument specifications and the theoretical detection limits for the analysed elements are given in Appendix B. Arsenic concentrations of some samples were determined in addition to the ICP analysis by the Flow Injection Hydride Generation Method, since this method results in a detection limit of 0.0005 mg/l, which is much lower than the ICP limit of 0.002 mg/l.



Map 4: Sampling locations on waste areas on the Port Radium peninsula.

In 1983, three litres of unfiltered water were analyzed for Ra-226, Pb-210 and uranium by the Saskatchewan Research Council (SRC). One half-litre samples of filtered and unfiltered water were analyzed by atomic absorption spectrophotometry at the Department of Indian Affairs and Northern Development (INAC) Laboratory in Yellowknife.

2.2.2. Solid Samples

The samples of tailings, soil and sediment collected in 1982 were homogenized, then oven dried and ground with a hand mortar. The ground samples were brought to constant weight at 75 C. For analysis by neutron activation a subsample of 0.5 g was irradiated at the slowpoke facility at the University of Toronto. An additional gram of the sample was used for analysis of Ra-226 and Pb-210 performed at the University of Waterloo in the laboratory of Dr. H. Sharma.

Percent loss on ignition (L.O.I) was determined on 3 to 4 g of material ignited at 450 C for 4 h at the University of Toronto.

Sediments, tailings and soil samples collected in 1983 were prepared and analyzed for metals in the DIAND Laboratory. Radionuclides were determined by SRC.

2.2.3 Acid Generation Potential

Tailings and sediment samples were collected for acid generation potential in 1983 in the same way as described earlier for metal or radionuclide analysis. The tests were performed by BC Research.

2.2.4 Data Processing and Statistical Methods

All data collected in 1982 were formatted in a manner compatible with other data on uranium mill tailings (KALIN - AECB DATABASE). The results of the water analysis in 1983 were added to the data of the previous year. Calculations were carried out using the SAS package (SAS version 82.3) supported by the University of Toronto Computer Services. The procedures PROC SORT, PROC TABULATE, PROC MEAN and PROC CLUSTER were used to generate the relevant statistics for the report (SAS, 1981).

3.0 RESULTS AND DISCUSSION

3.1 Locations and Characteristics of the Waste Material

3.1.1 Location and Physical Characteristics

The location of waste material is important in relation to potential environmental degradation. For example, Garbage Lake, Murphy Lake and Radium lake are confined areas, preventing direct contact of the tailings with Great Bear Lake, while the Silver Point tailings beach lies at the edge of Cobalt Channel. Waste water from the confined areas could reach Great Bear Lake only through subsurface seepage or above-ground flow. The texture and pH of wastes will indicate the type of potential problems such as leaching of contaminants. The characteristics of the leachate is in turn determined by the chemical composition of the waste.

Major differences in pH and electrical .conductivity were noted between some materials from West Adit and the tailings from Silver Point, Murphy Lake and Garbage Lake. These differences are important with respect to the potential for mobility of metals and radionuclides. In Appendix A, the values of pH, electrical conductivity, percent moisture content and organic content (L.O.I.) are summarized for ten locations. In Table 1, a summary of the ranges of pH and conductivity is presented for silver tailings from Garbage Lake and Silver Point , for sediments from Cobalt Channel and LaBine Bay and for the solids from the West Adit Area.

These results suggest, given the pyritic uranium ore and the carbonaceous silver ore, that the material in West Adit originated with the uranium mining activities because of the low pH in some samples. Furthermore, West Adit is located in the direction in which the uranium tailings have been said to have been discharged after Radium Lake and Murphy lake were filled (p.c. C. Lendrum , E. Joe). Acidity alone, however, does not indicate the origin of the waste, particularly as exposed rock in this area is often "streaked" as a result of pyrite oxidation. Control material collected had a pH of 3.1 (Appendix A).

The texture and stratification of materials are important factors affecting the mobility of metals and radionuclides. Fine tailings generally contain higher concentrations of radionuclides than coarse tailings. Thus the potential for leaching of contaminants from a layer of fine tailings on the surface is greater than from a layer of coarse tailings on the surface. Fines are more easily dispersed by wind and more easily suspended in water when dry. The profiles of Silver Point, Murphy Lake and West Adit (Figure la, b and c) identify the relative location of the tailings textures in the pits.

TABLE 1: RANGES OF pH AND ELECTRICAL CONDUCTIVITY IN WASTE MATERIAL

LOCATION	pH			CONDUCTIVITY. umhos/cm		
TAILINGS	min	max	n	min	max	n
Silver Point and Garbage Lake	7.2	8.6	15	140	850	15
SEDIMENTS						
LaBine Bay and Cobalt Channel	7.4	8.6	15	430	5200	15
TAILINGS						
West Adit	3.6	7.6	19	80	220	19

The stratification in the Silver Point tailings (Fig. la) was homogeneous. In all profiles examined in the main tailings area (samples 8T5,6,7), approximately 60 cm of coarse tailings overlay very thin layers of fine, clay-like tailings. Two of the profiles were taken from trenches of about 40 m in length. The thickness of the coarse layer varied little throughout the trenches. In other locations the coarse layer was somewhat thinner (8T1 and 8T2).

In the Murphy Lake profiles (Fig. lb), a different stratification of tailings material was evident. A greater variety of textures and waste materials was observed. Numerous very thin strata of fine tailings, a thin layer of coarse tailings and, in some cases, process slimes deposited on the surface could be differentiated. Pits were examined only in areas where waste rock did not cover the surface.

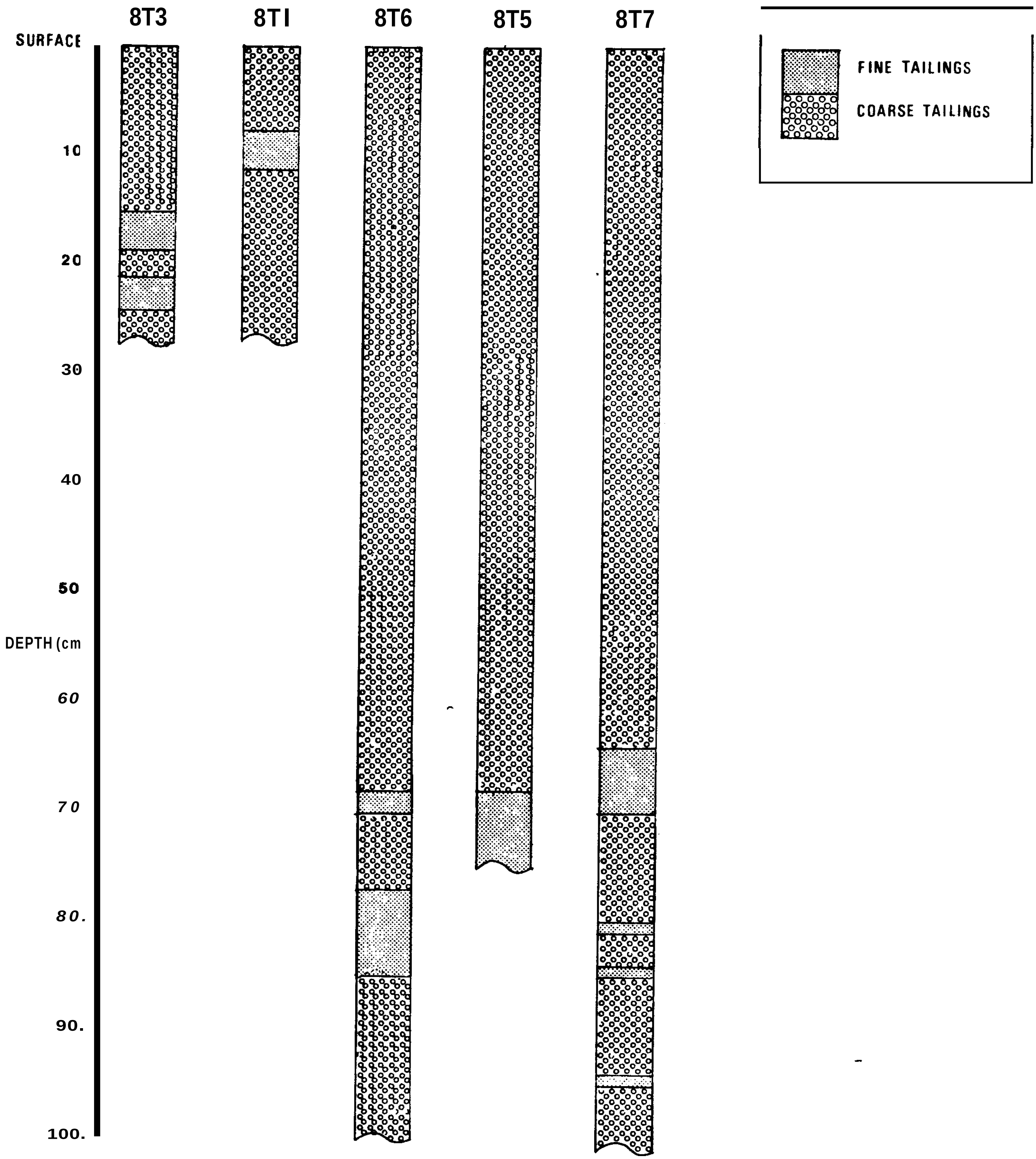


Figure la: Depth and texture of strata in profiles on the Silver Point tailings area.

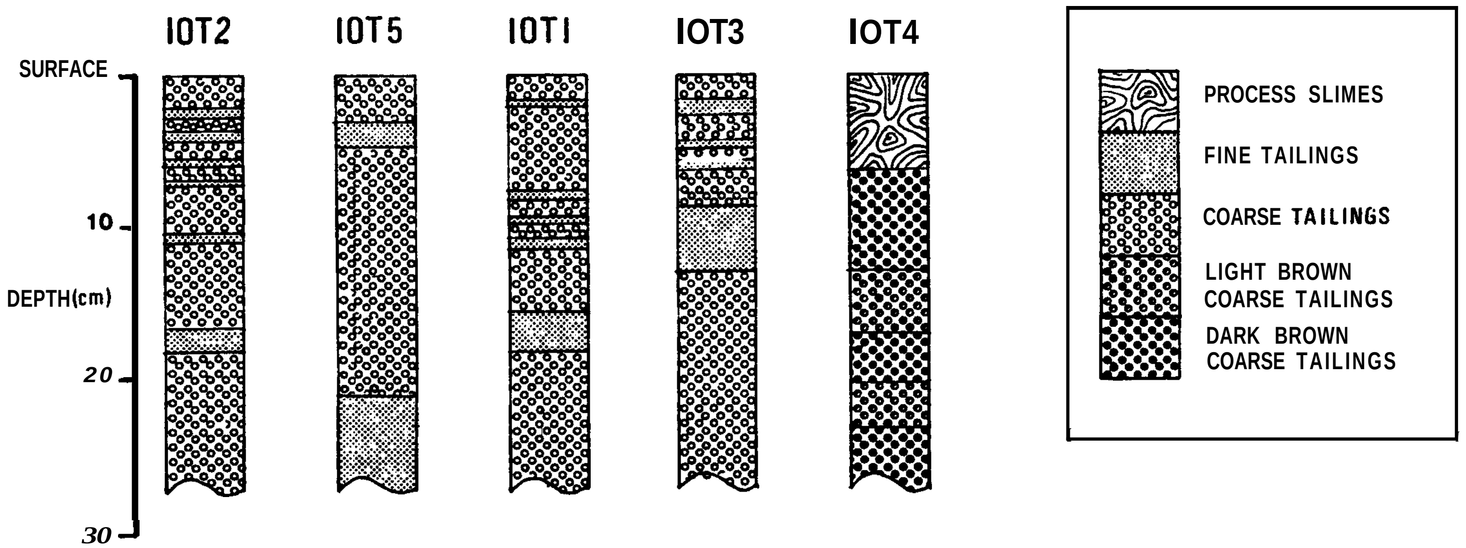


Figure 1 b: Depth and texture of strata in profiles examined on the Murphy Lake tailings area. Numerous, narrow layers comprise this tailings deposit.

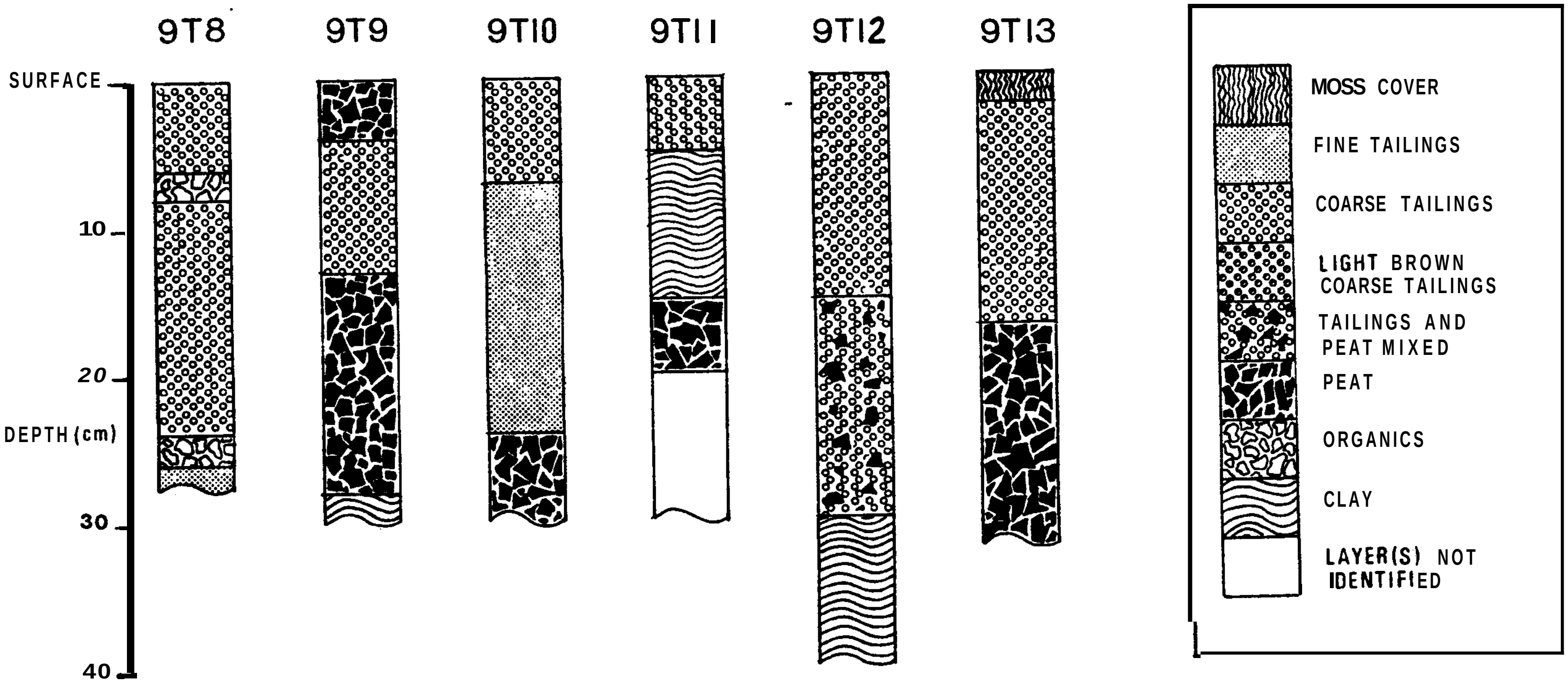


Figure 1c: Depth and texture of strata in profiles examined on the West Adit tailings sites.

The stratification of West Adit profiles was the most varied (Fig. 1c). In some locations, peat or moss covered coarse tailings (9T13), while at other locations coarse tailings were on the surface and strata of organic soil or fines were underneath.

The stratification of waste material was clearly different in all three locations. Coarse material was mainly deposited at Silver Point due to the movement of tailings fines into Cobalt Channel along with the tailings liquors, leaving behind only the more rapidly-settling coarse tailings. In Murphy Lake a more regular pattern of fines and coarse tailings were noted, indicating that tailings liquors had ponded providing adequate time for the fines to settle out. On West Adit, the layering was varied, indicating that this area had received wastes in a rather random fashion and was unlikely part of a regular tailings discharge system.

3.1.2 Chemical Characteristics

3.1.2.1 Radionuclides

The results of radionuclide analysis of samples collected on the peninsula are given in Fig. 2. Radionuclide concentrations in sediments collected from the surrounding waters are given in Fig. 3.

Clearly, the West Adit area had the highest concentrations of Ra-226 and Pb-210. Two sediment samples, 5S3 (tailings) and 5S4 (natural sediment), also contained elevated concentrations of radionuclides, with 112 and 325 pCi/g (dry weight) of Ra-226, and 56 and 93 pCi/g of Pb-210, respectively. These values fall within the concentration ranges of samples from the West Adit area. From these data, it is evident that the Ra-226 and Pb-210 concentrations in West Aditmaterial were high compared to the tailings from Silver Point and Garbage Lake. The results of radionuclide analysis of samples collected in these three areas in 1982 and 1983 are presented in Table 2.

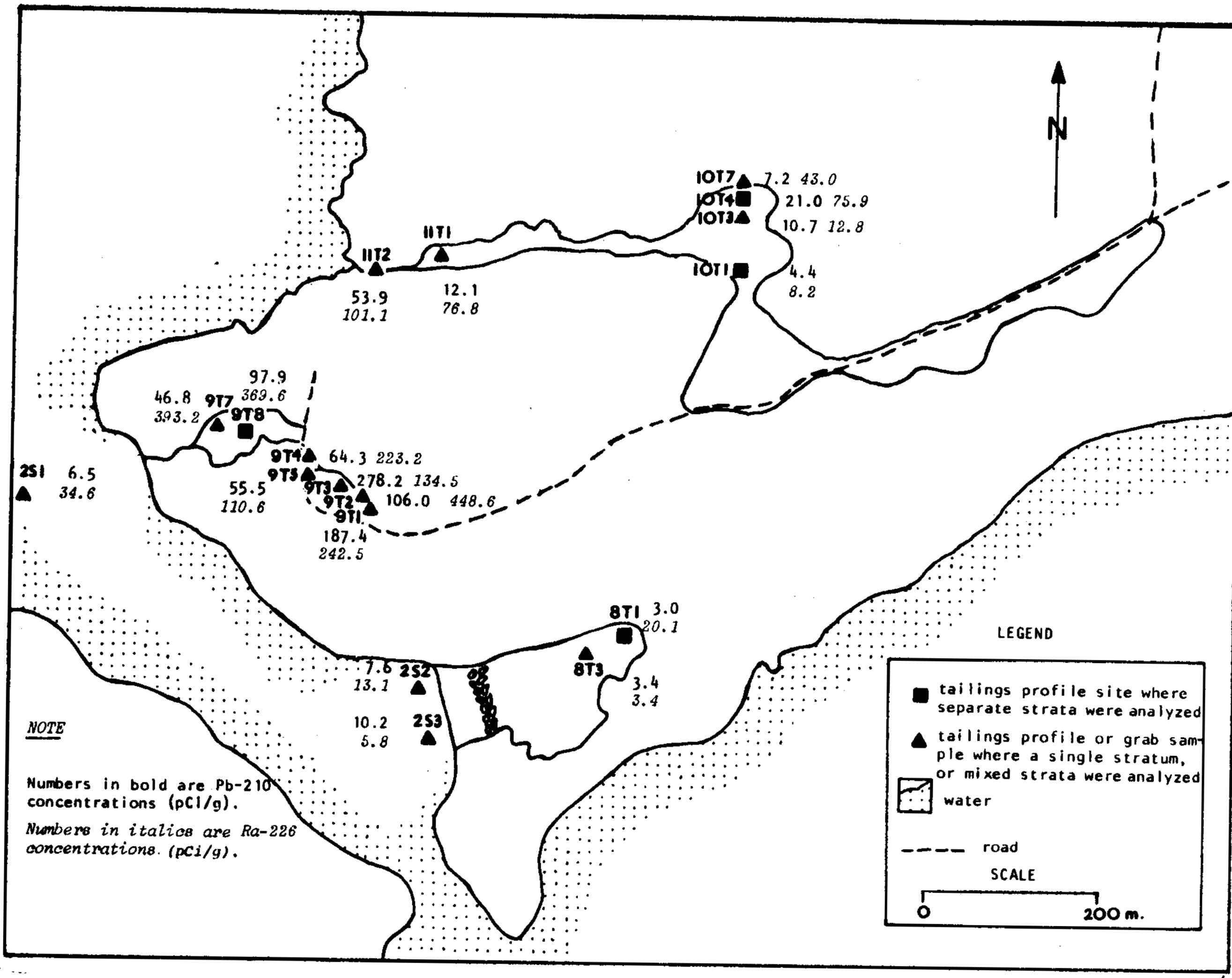


Figure 2: Radionuclide concentrations of solid samples collected on the Port Radium peninsula in 1982.

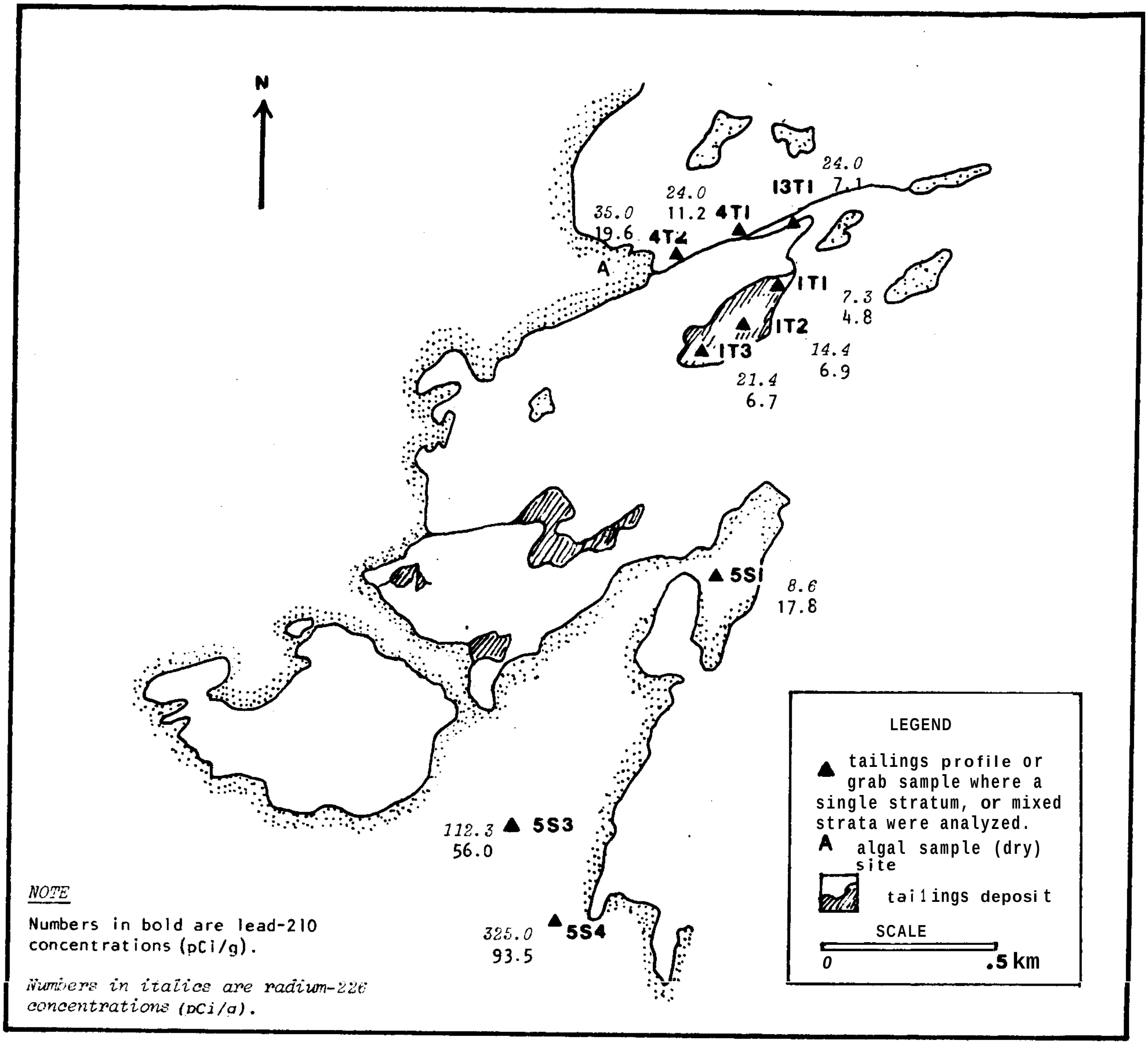


Figure 3: Radionuclide concentrations of sediment samples collected in 1982 from the waters surrounding the Port Radium peninsula.

TABLE 2 : RADIONUCLIDES IN TAILINGS FROM SILVER POINT, WEST ADIT AND GARBAGE LAKE

1982 (Waterloo)				1983 (SRC)			
Sample Code	Texture	Concentration Ra-226 pCi/g	Concentration Pb-210 pCi/g	Sample	Texture	Concentration Ra-226 pCi/g	Concentration Pb-210 pCi/g
WEST ADIT							
9T1	fines	243	187	9T9	coarse	946	946
9T2	fines	449	106	9T10	coarse	811	811
9T3	fines	135	278	9T10	peat	378	324
9T4	fines	223	64	9T11	coarse	676	676
9T5	mixed	109	60	9T12	coarse	811	676
9T7	coarse	521	59	9T13	coarse	811	676
9T7	fines	266	34				
9T8	slimes	368	189				
9T8	soil	246	32				
9T8	fines	495	73				
SILVER POINT							
8T1	mixed	20	30	8T4	water saturated	67	54
8T3	mixed	3	3	8T5	coarse	19	5
GARBAGE LAKE							
1T1	mixed	7	5	1T5	mixed	54	24
1T2	mixed	14	7				
1T3	mixed	21	7				

The concentrations of Ra-226 in the West Adit material ranged from 109 (composite sample) to 521 pCi/g (coarse tailings sample). The materials collected in 1983 were mainly coarse, surface tailings. The sample 9T9 was peat, 9T10-9T12 were coarse tailings and 9T13 contained a thin layer of moss with coarse tailings (Fig. 1c).

The concentrations determined in 1983 are generally consistent with those from the previous year, in that they are higher in West Adit material than in Silver Point tailings. However, 1983 results were higher than those reported in 1982. As well, the concentrations of the two radionuclides were unusually similar in 1983 samples. These similarities were explained as the result of incremental rounding (p.c. G. Smithson). In general, it can be stated that West Adit material has 10 to 100 times higher Ra-226 and Pb-210 concentrations 'than the tailings at Silver Point and Garbage Lake.

3.1.2.2 Metals

The mining history suggested that most of the uranium tailings presently reside in Great Bear Lake. Several studies indicated potential, long-term environmental problems which could be associated with these tailings (Moore 1981 and Falk, Miller and Kostiuk, 1973). It was therefore important to differentiate clearly between silver tailings and uranium wastes. This can not be done based on acidity, radionuclide concentrations and heavy metals alone.

The concentrations of 13 elements (Co, U, Al, Mg, Mn, Na, Ba, Va, Cl, I, Dy, Sr, Br) were determined by neutron activation analysis of solid samples collected in 1982. Those results were used to fingerprint the material with a cluster analysis. This statisical procedure groups samples according to their elemental similarities. Silver Point tailings were placed into a group significantly different from tailings from West Adit, Murphy Creek and Murphy Bay suggesting differences in the materials. A detailed description of the results is given in Appendix C along with the dendrogram.

The characteristics of known waste material on land can be used to identify the type of tailings in the sediments in Great Bear Lake, through differentiating the elemental composition of the silver tailings from uranium tailings. Metal concentrations in the waste material also suggest differences between the materials (Table 3).

Arsenic concentrations in West Adit coarse surface tailings were somewhat higher than those in the Silver Point tailings, but the concentrations of lead and zinc were lower. A peat sample from the West Adit Tailings Area (profile 10T10) had 3% copper, suggesting that Cu was bound to the organic material. The number of analyses for both radionuclides and metals was small, but some metal concentrations were distinctly different, supporting the conclusion that a difference in origin of the waste materials existed.

TABLE 3: METALS IN TAILINGS AND SEDIMENTS

Sample Location	Sample Code	Ni	AS	CD	CU	FE	PB	HG	ZN	CO
			mg/kg mean ± standard deviation							
Silver Point	8T4	1	2163	1.3	5750	41300	1440	3.5	1450	562
Silver Point	8T5	3*	2142 ±102	0.8 ±0.1	4490 ±272	40770 ±2632	1277 ±27	**2.6	833 ±7	55 ±26
Garbage Lake	1T4/5	2	1553 ±130	0.43 ±0.1	950 ±28	65895 ±4292	1475 ±140	1.1 ±.3	573 ±99	226 ±393
West Adit	9T9	1	3591	0.23	2870	36250	337	1.2	266	55
Top Coarse	9T10/12	3	3253 ±471	0.3 ±0.3	3400 ±814	34420 ±5240	359 ±81	1.2 ±0.2	390 ±153	331 ±486
West Adit N	9T13	3*	1413 ±550	2.8 ±.1	7343 ±136	45933 ±3442	731 ±14	0.8 ±.3	1883 ±223	1800 ±338
Sediments Labine Bay	5S12/13	2	572 ±744	.35 ±.2	1765 ±2227	29055 ±2905	132 ±132	0.3 ±.3	184 ±99	300 ±393

* replicate analyses
** n=1

3.1.3 Acid Generation Potential

Physical and chemical composition, and the stratification of waste materials are essential characteristics required to assess their environmental implications. However, the potential for mobilization of contaminants may also depend on the potential for generation of acid. If the waste materials contain sulfur or sulfides, microbial oxidation will generate sulfuric acid which will increase the mobility of metals and radionuclides.

Acid generation tests determine the potential of a mineral material (soil, rocks, tailings etc.) to produce acid. The tests are performed under optimal conditions in the laboratory. On the actual waste site, however, oxygen saturation and temperature may not be optimal for the bacteria. In Port Radium the temperatures for most of the year would be far below those at which microbial acid generation could occur. As well, oxygen needed by the bacteria will be limited or absent in the deeper waters. However, in shallow parts of the lake acid generation could occur in the summer months, resulting in slow environmental degradation.

The results of the acid generation tests performed by BC Research on 4 samples are given in Tables 4a and 4b.

TABLE 4A: INITIAL ACID PRODUCTION TEST

Sample Code	Sample Description	%S	Theoretical Sulfuric Acid kg/ tonne	Natural pH 10g Sample +10 ml Water	Acid Consumption kg Sulfuric Acid/tonne	Potential Acid Producer
6S3	Murphy Bay Sediment	0.80	24.5	9.31	16.7	yes
9T11	West Adit Surface Coarse	1.76	53.9	5.38	10.1	yes
1S5	Garbage Lake	1.06	32.4	8.82	167.8	no
5S4	LaBine Bay Sediment	1.07	32.7	8.01	87.3	no
8T5	Silver Point Tailings	0.92	28.2	8.64	109.8	no

TABLE 4B: CONFIRMATION TEST FOR ACID PRODUCTION POTENTIAL

Sample code	pH before addition of extra sample	pH after addition of 0.5 x original weight	pH after addition of 1 x original weight	Confirmed acid producer
6S3	2.05	3.04	3.48	yes-weak
9T11	1.78	2.28	2.75	yes-weak

Materials from Garbage Lake, Silver Point Tailings area and outer LaBine Bay clearly consumed more acid than could be produced and, therefore, have no potential to produce acid. In the field, the tailings slurries from these locations had pH values ranging from 8.0 to 8.8 (Appendix B). These field measurements supported the results of the acid generation tests.

If the material consumes less acid than it produces, it could be a potential acid generator. If the initial titration test indicates that insufficient neutralizing or acid consuming capacity exists, microbial activity by Thiobacillus ferrooxidans could produce acid. A second test is performed, where the sample is inocculated with the bacteria. The pH of the material after several 24 h periods determines the endpoint of the test, ie., the acid generation potential. West Adit and Murphy Bay samples were weakly acid generating (Table 4b).

The findings correspond with the acidic pH determined in thefield in and the laboratory for West Adit material, but in the Murphy Bay sediment, the pH was alkaline (8.8) in the field and remained so after 24 h at room temperature (Appendix B, Section 3.2). In fact, the alkaline pH of Murphy Bay tailings indicated that, although an acid generation potential existed, the sediments were either not infected with Thiobacillus ferroxidans or the conditions were unfavorable for the bacteria (too cold and low in oxygen) to produce acid.

In the waterlogged area of Silver Point, tailings water was extracted from the tailings by pressure. The concentrations of radionuclides in filtered and unfiltered samples of this water gave some indication of the concentrations of soluble constituents in the tailings. The acidified unfiltered sample indicated the concentrations which could solubilize, should the tailings become acidic. As expected, Ra-226 was higher in the acidified unfiltered sample than in the filtered, with 81 versus 11 pCi/l, respectively. The same trend for Pb-210 was observed, with the unfiltered water containing 51 pCi/l and the filtered 4 pCi/l.

3.1.4 Vegetation on the Waste Material

Vegetation established on waste material is a potential source of contamination to herbivorous animals, should radionuclides be transported into the vegetation. Therefore, one of the environmental aspects which was investigated was the plant invasion of the waste sites.

The plants collected on waste areas represented those species which were most frequently encountered. These species were considered to be the major components of the plant communities which were in close association with the wastes. In Appendix C, detailed listings of the plants are given.

The most diverse community of vegetation was found along Murphy Creek where 15 species from eleven families were recorded. Only ten species from 6 families were growing on the West Adit waste site. On waste rock near the mill building and on sections of Radium Lake, some species from the Mustard and Pea family were frequent, represented by Rock Cress and Oxytropis. However, the vegetation cover was never extensive. Although percentage vegetation cover was not systematically evaluated, it is generally below 50 %, with the exception of areas where terrestrial moss provided 100 % cover.

The waste rock areas close to Shaft #1 were free of vegetation. In order to make a prediction of the time required for this material to become colonized, an old waste rock pile was visited on the northern slope of Cross Fault Lake (Map 1). On this small waste rock pile, at least 40 years old, lichens, mosses and the occasional hummock of Kentucky bluegrass (Poa pratenses) were noted. One 25 cm tall Paper Birch (Betula papyrifera) was 25 years old, suggesting that if colonization of waste rock occurs at all, it will be extremely slow.

The brief vegetation survey can be summarized with respect to the waste material. Waste rock will not be colonized extensively, while tailings areas will either remain free of vegetation or eventually become covered with moss and horsetails (Equisetum spp.). Since these plants are not major components of wildlife diet, they are likely not a source of contamination in the terrestrial pathway, even if they should accumulate radionuclides.

3.2. Waste Water

3.2.1 Garbage Lake System and West Adit Melt Water

A thermocline was observed in a Garbage Lake temperature profile measured in August 1982 (1W7,1W1,1W4 in Fig. 4). In a small, shallow lake this is unusual, since wind action alone should mix the entire water column. The stratified condition may have been maintained by a chemical gradient.

Stratified temperature profiles were again observed in 1983 (1W10 ,1W8 and 1W9) in Garbage Lake at the same locations indicating that the thermocline appeared to be established shortly after snowmelt. Dissolved oxygen concentrations increased with depth, then decreased between the depths of 3 to 4 m for all three stations, as was the case in 1982 in profiles 1W1 and 1W4.

Oxygen levels at the sediment-water interface could have an effect on water quality. At the time of sampling, this interface was anoxic and the water just above the sediment had on average less then 3 ppm oxygen, indicating oxygen depletion of the deeper water (Fig 4).

During the survey in 1982, blooms of algae were found at the mouth of Bear Creek and on the Silver Point tailings beach (Appendix C, p25). Biological activity in Garbage Lake was, therefore, a reasonable possibility and hence was determined in 1983. Furthermore, an evaluation of primary productivity comparing Garbage Lake to Great Bear Lake provided an indication of the potential effects on the rate of primary productivity in Bear Bay.

The productivity in Garbage Lake was about 40 times higher than in Great Bear Lake (Appendix C pg. 6). Nutrients in effluent from the waste sites may have increased the primary productivity in ultra-oligotrophic Great Bear Lake.

In order to quantify differences in the chemical composition of surface versus bottom water in Garbage Lake, two sets of samples were collected in 1983. In Table 5, the elemental compositions of samples for two stations (1W8 and 1W10 map 2) are listed. At site 10, the concentrations of As, Fe, Ni and Co in filtered and unfiltered water were higher at the bottom of the lake than on the surface. At station 8, the reverse was the case. The absolute differences were only large for iron in sample 10 (unfiltered bottom, 3.4 mg/l, unfiltered top, 0.04 mg/l). The

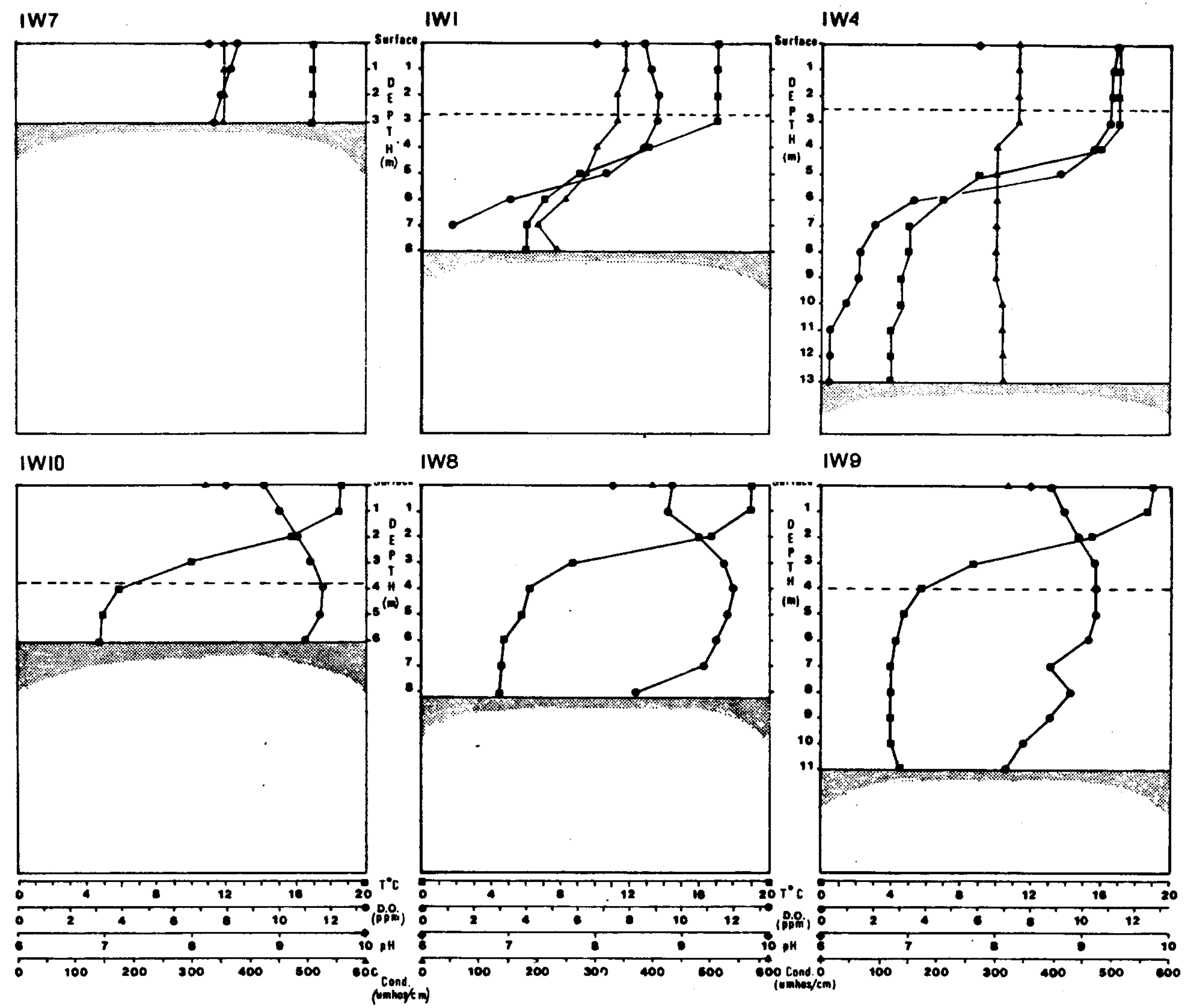


Figure 4: Dissolved oxygen, temperature, conductivity and pH profiles of Garbage Lake (Dotted lines indicate secchi depths).

concentrations for all other elements were in the same range. Clearly, the number of samples available for evaluation of differences between bottom and surface water were insufficient but some differences were indicated for site 10.

The water quality of the Garbage Lake system is given in Table 5. This system consists of the Lake itself and of Garbage Creek which joins Bear Creek before flowing into Bear Bay.

In the summer of 1982, the volume of surface seepage flowing from Garbage Lake into Garbage Creek was small. Because the quantity and quality of seepage may be different during snowmelt, and because the freeze-thaw cycle could liberate significant fractions of tailings fines present in the creek bed, this site was re-sampled in 1983. The seepage water quality and flow rate appeared the same as in the previous summer. In order to assess whether this small volume of Contaminants or newly released fines was having an effect on the water quality of the lower Garbage Lake system, water was sampled above and below the junction of Garbage Creek with Bear Creek, as well as in Bear Bay. The analyses of filtered and unfiltered water samples from below the junction indicated that the minor amount of seepage was diluted with Bear Creek water. No decrease in Bear Creek water quality after mixing with Garbage Creek effluents was observed (Table 5).

In order to compare the melt water quality from the West Adit area with that of Garbage Lake water, the concentrations are also reported in Table 5. It is quite evident that Ra-226, Pb-210, As, Cu, Zn, and Co were present in much higher concentrations in West Adit water than at any location in the Garbage Lake system. The high concentrations of these elements in the waste solids and the acidity of some of the waste materials contributed to the contamination of the water. Fortunately, only small quantities of the water were discharged the West Adit tailings area during spring melt, while during the remainder of the year the West Adit tailings area likely contains the contaminated water.

Location	Sample	1982-3	PB210	RA 226	U	PS	CD	CU	FE	PB	NI	ZN	CD
			pCi/l		mg/l								
Garbage Lake	Surface Filter	82	*	*	0.1280	0.0500	*	•	*	*	0.0600	•	*
	Filter	82	*	•	*	0.0500	*	*	0.0200	*	0.0700	*	*
	Surface Filter	82	*	*	0.1960	0.0400	*	*	0.0100	*	0.0600	*	*
	Filter	82	•	*	0.5440	0.0600	*	*	*	*	0.0700	*	*
	Surface Filter	82	•	*	0.2790	0.0500	*	•	*	0.0800	0.0500	0.100	*
	Filter	82	*	*	0.1500	0.0500	*	•	*	*	0.0600	*	*
	Surface Filter	82	*	*	0.3550	0.0600	*	•	0.0200	*	0.0800	0.0100	*
	Filter	83	*	*	*	0.0500	0.0002	0.0022	0.0200	*	0.0351)	0.0100	0.0019
	Surface Unfilter	83	1.1000	1.9000	0.0610	0.0820	*	0.0022	0.0720	*	0.0370	0.0100	0.0020
	Surface Filter	83	*	*	*	0.0790	•	0.0021	0.1100	0.0002	9.0390	0.0140	0.0020
	Surface Unfilter	83	*	*	*	0.0680	*	0.0020	0.0540	*	0.0034	0.0110	0.0020
	Surface Filter	83	*	•	*	0.0580	*	0.0023	0.0890	*	0.0380	0.0140	0.0030
	Unfilter	83	*	•	*	0.1050	*	*	0.0560	*	0.0034	0.0180	0.0023
	Bottom Filter	83	*	*	*	0.0082	*	0.0012	0.0400	*	0.0051	0.0260	0.0019
	Unfilter	83	1.4000	1.9000	0.0920	0.0082	0.0001	0.0012	0.0490	0.0002	0.0280	0.270	0.0018
	Bottom Filter	83	*	•	*	0.1900	*	0.0023	1.1000	0.0120	0.0650	0.0220	0.0120
	Unfilter	83	*	*	*	0.2970	*	0.0157	3.4330	0.0043	0.0750	0.0330	0.0320
Bear Bay	Surface Filter	82	*	*	*	0.0200	*	*	*	*	•	*	*
	Filter	82	*	*	0.1730	*	*	*	0.0100	0.0600	*	0.0100	*
	Surface Filter	83	*	*	*	0.0032	*	0.0030	0.0240	*	*	0.0460	0.0013
	Unfilter	83	2.7000	0.30000	0.0008	0.0037	*	0.0030	0.0240	*	*	*	0.0012
	Surface Filter	83	*	*	*	*	*	*	0.0480	0.0004	*	0.0380	*
	Unfilter	83	*	*	•	*	*	*	0.0860	0.0004	*	0.0380	*
Bear Creek	Surface Filter	82	*	*	0.2640	0.0800	*	*	0.0200	*	0.0200	*	*
	Filter	82		*	*	*	*	*	•	*	*	0.0100	*
	Surface Filter	83	*	*	*	0.0029	*	0.0015	*	*	*	0.0180	0.0020
	Unfilter	83	6.8000	*	0.0037	0.0034	*	*	*	*	0.0012	0.0190	0.0020
West Adit	Surface Filter	83	*	*	*	7.0000	0.0013	0.0700	0.0350	*	0.0490	0.2400	0.7300
	Unfilter	83	51.4000	10.80000	0.3510	7.7000	0.0026	0.0770	0.1070	*	0.1000	0.2400	0.7400
	Surface Filter	83	*	*	*	0.0018	0.0001	*	0.0530	*	*	*	0.0042
	Unfilter	83	81.1000	0.3000	0.0014	0.0025	0.0001	*	0.0530	*	*	*	0.0042
Garbage Creek	Surface Filter	83	*	*	*	0.0110	*	0.0022	0.0790	*	0.0072	0.0110	
	Unfilter	83	1.1000	3.0000	0.0065	0.0180	*	0.0060	0.4760	0.0015	0.0360	0.0160	0.0068

* Analysis not done

TABLE 5: RADIONUCLIDE AND METAL CONCENTRATIONS IN WASTE WATERS

3.3. Water Quality Monitoring Data from the Shoreline of the Peninsula

3.3.1 Historical Monitoring Data

Data collected to monitor the Echo Bay Mine during operation have been summarized in detail in Appendix C (pg. 12 - 15). Information was available for LaBine Bay close to station 5W6, for Cobalt Channel between stations 2W6 and 2W3 (Map 2), and for the Garbage Lake system. These data, dating back to 1969 for some locations, are used to determine:

(a) whether the quality of water in Garbage Lake has changed since minewater was first disposed there; and

(b) whether the water quality of Cobalt Channel and Labine Bay, measured during the mine operation, has remained the same since the closure of the operation.

Analyses of Garbage Lake water were available for 1974 when treated effluent had not yet been discharged. The characteristics were similar to water collected in 1983 and 1984, despite the fact that contaminants such as As, Cd, Cu, Fe, Pb, Ni, Zn and Ra-226 were added to the Lake with minewater and tailings from 1974 to 1982. Nevertheless, despite disposal of these contaminants, water in Garbage Lake in 1983 was very similar to pre-disposal conditions.

The monitoring records for stations in Cobalt Channel and LaBine Bay exhibited large variations in concentrations of many parameters, thus comparisons with data from 1983 and 1984 are inconclusive. Metal concentrations in samples collected from the same site were sometimes elevated and at other times not. Similarly, some samples collected during the present study contained elevated concentrations, The higher values were rare and localized to areas immediately exposed to waste rock and the tailings beach.

In general, the variability in elemental concentration was large and concentrations were frequently reported at or below the detection limit of the analytical method used. Nevertheless, when comparing the records of water quality before and after shutdown of the mine, no trends of either increasing or decreasing metal or radionuclide concentrations were noted in Cobalt Channel and Labine Bay.

3.3.2 Water Quality along the Shoreline

During the 1982 survey, higher concentrations of As, Pb and U were reported in some isolated instances (see dot maps in Appendix C, pg. 16 to 24). As these concentrations were not related to continuous discharges of wastewater as discussed previously, they may have been due to suspended particulates. During run off, particulates in the meltwater could be introduced from tailings areas or waste rock. This question was addressed in 1983 shortly after spring runoff. Filtered and unfiltered water quality data are compared for shoreline and all other locations in Tables 6a-c.

Iron concentrations in unfiltered water were consistently slightly higher than in the filtered water suggesting some contribution from particulate matter (Table 7).

The differences in the concentrations of As between filtered and unfiltered samples (Table 6a) were variable, an occurrence typical of arsenic throughout the monitoring records and in earlier work. The filtered and unfiltered water of Great Bear Lake contained Cu, Co, Ni, and Zn in the same concentration ranges (Tables 6 a and b). From these comparisons, the existence of an annual input of particulates from the waste material on the Port Radium peninsula to the water of Great Bear Lake was not evident.

Sampling stations on waste rock shores in Labine Bay and on Silver Point tailings indicated higher concentrations of dissolved As, Cu ,Pb , Ni, U and Co. Cobalt, a metal which is rich in the Port Radium ore, was found in higher concentrations in water along the waste rock on the shore, around the rock causeway, on Silver Point tailings beach and in Garbage Lake than in the open water surrounding the peninsula (see dot maps in Appendix C pg 4). Cobalt was the the only element in which this trend of increased concentrations along waste rock or tailings was pronounced and consistent.

These results suggest that the occasional high elemental concentrations discussed earlier were likely a result of weathering of the waste rock along the shores. This would also apply to the uranium concentrations. However, for this element, in addition to weathering of waste rock, natural outcrops likely produce elevated concentrations along the shore, as for example in West Bear Bay, located along vein #2. See Appendix C for a detailed map of concentration ranges along the shoreline for both years.

Location	Sample		NI MEAN	NI STD DEV	NI N	CU MEAN	CU STD DEV	CU N	AS MEAN	AS STD DEV	AS N
			-----	-----	-----	mg/l	-----	-----	-----	-----	-----
Great Bear Lake											
KO3	Surface	Filter	•	•	0.0000	*	*	0.0000	*	*	0.0000
		Unfilter	*	*	0.0000	*	*	0.0000	•	*	0.0000
KO4	Surface	Filter	*	*	0.0000	*	*	0.0000	0.0023	*	1.0000
		Unfilter	0.0260	*	1.0000	*	*	0.0000	0.0043	*	1.0000
Garbage Lake	Surface	Filter	0.0562	0.0153	10.0000	0.0022	0.0001	3.0000	0.0547	0.0105	10.0000
		Unfilter	0.0146	0.0194	3.0000	0.0022	*	1,0000	0.0850	0.0187	3.0000
	Bottom	Filter	0.0350	0.0424	2.0000	0.0023	*	1,0000	0.0991	0.1286	2.0000
		Unfilter	0.0515	0.0332	2.0000	0.0157	*	1.0000	0.1526	0.2042	2.0000
Cobalt Channel	Surface	Filter	0.0300	*	1.0000	0.0190	*	1.0000	0.0630	0.0805	2.0000
		Unfilter	*	•	0.0000	0.0350	*	1.0000	0.0076	•	1.0000
	Bottom	Filter	*	*	0.0000	•	*	0.0000	*	•	0.0000
Bear Bay	Surface	Filter	*	*	0.0000	0.0030	*	1.0000	0.0116	0.0119	2.0000
		Unfilter	*	*	0.0000	0.0030	*	1.0000	0.0037	*	1.0000
Bear Creek	Surface	Filter	*	*	0.0000	*	*	0.0000	0.0414	0.0545	2.0000
		Unfilter	*	*	0.0000	*	*	0.0000	0.0034	*	1.0000
Labine Bay	Surface	Filter	0.0107	0.0116	4.0000	0.0038	*	1.0000	0.0560	0.0932	8.0000
		Unfilter	0.0046	0.0033	3.0000	*	*	0.0000	0.0106	0.0164	5.0000
Murphy Bay	Surface	Filter	*	*	0.0000	*	*	0.0000	•	•	0.0000
Silver Point **	Surface	Filter	0.2100	*	1.0000	0.2100	*	1.0000	4.2000	*	1.0000
		Unfilter	0.2500	*	1.0000	0.1900	*	1.0000	4.3000	*	1.0000
West Adit	Surface	Filter	0.0490	*	1.0000	0.0700	*	1.0000	7.0000	*	1.0000
		Unfilter	0.1000	*	1.0000	0.0770	*	1.0000	3.8512	5.4430	2.0000
Garbage Creek	Surface	Filter	0.0072	*	1.0000	0.0022	*	1.0000	0.0110	*	1.0000
		Unfilter	0.0360	*	1.0000	0.0060	*	1.0000	0.0180	•	1.0000

* Analysis not done ** Pore water

TABLE 6a: NICKEL, COPPER AND ARSENIC CONCENTRATIONS IN WATER COLLECTED IN 1982 AND 198:

Location	Sample	mg/l	CD MEAN	CD STD DEV	CD N	ZN MEAN	ZN STD DEV	ZN N	CD MEAN	CD STD DEV	CD N
Great Bear Lake			----	----	----	mg/l	----	----	----	----	----
K03	Surface	Filter	*	*	0.0000	0.0320	*	1.0000	*	*	0.0000
	Surface	Unfilter	*	*	0.0000	0.0330	*	1.0000	*	*	0.0000
K04	Surface	Filter	*	*	0.0000	0.0320	*	1.0000	*	*	0.0000
	Surface	Unfilter	*	*	0.0000	0.0330	*	1.0000	*	*	0.0000
Garbage Lake .	Surface	Filter	0.0002	*	1.0000	0.0120	0.0023	4.0000	0.0030	*	1.0000
	Surface	Unfilter	*	*	0.0000	0.0145	0.0049	2.0000	0.0023	*	1.0000
	Bottom	Filter	*	*	0.0000	0.0240	0.0028	2.0000	0.0120	*	1.0000
		Unfilter	*	*	0.0000	0.0300	0.0042	2.0000	0.0320	*	
Cobalt Channel	Surface	Filter	*	*	0.0000	0.0360	*	1.0000	*	*	0.0000
		Unfilter	*	*	0.0000	0.0370	*	1.0000	*	*	0.0000
	Bottom	Filter	*	*	0.0000	0.0300	*	1.0000		*	
Bear Bay	Surface	Filter	*	*	0.0000	0.0313	0.0189	3.0000	*	*	0.0000
		Unfilter	*	*	0.0000	0.0380		1.0000	*	*	0.0000
Bear Creek	Surface	Filter	*	*	0.0000	0.0140	0.0057	2.0000	*	*	0.0000
		Unfilter	*		0.0000	0.0190		1.0000			0.0000
Labine Bay	Surface	Filter	*	*	0.0000	0.0316	0.0087	7.0000	0.0108	0.0070	8.0000
		Unfilter	*	*	0.0000	0.0284	0.0078	7.0000	0.0058	0.0053	3.0000
Murphy Bay	Surface	Filter		*	0.0000			0.0000			0.0000
Silver** Point	Surface	Filter	0.0016	*	1.0000	2.4000	*	1.0000	7.2000	*	1.0900
		Unfilter	0.0012	*	1.0000	1.4000	*	1.0000	6.2000	*	1.0000
West Adit	Surface	Filter	0.0007	0.0008	2.0000	0.2400	*	1.0000	0.3671	0.5132	2.0000
		Unfilter	0.0026		1.0000	0.2400	*	1.0000	0.3721	0.5203	2.0000
Garbage Creek	Surface	Filter		*	0.0000	0.0110	*	1.0000		*	0.9000
		Unfilter	*	*	0.0000	0.0160	*	1.0000	0.0068		1.0000

* Analysis not done ** Pore water
note; Concentrations are only reported if twice the detection limit

TABLE 6b: CADMIUM, ZINC AND COBALT CONCENTRATIONS IN WATER COLLECTED IN 1982 AND 1983

Location	Sample		RA 226 MEAN	RA 226 STD DEV	RA 226 N	PB210 MEAN	PB210 STD DEV	PB210 N	PB MEAN	PB STD DEV	PB N	U MEAN	U STD DEV	U N
			pCi/l						mg/l					
Great Bear Lake														
KO3	Surface	Filter	•	•	0.0000	*	•	0.0000	•	•	0.0000	•	*	0.00
		Unfilter	*	•	0.0000	6.8000	*	1.0000	•	•	0.0000	0.0013	•	1.00
KO4	Surface	Filter		•	0.0000	•	*	0.0000	•	•	0.0000		*	0.00
		Unfilter	0.3000	*	1.0000	9.5000	•	1.0000	*	•		0.0015,	•	1.00
Garbage Lake	Surface	Filter	•	•	0.0000	*	•	0.0000	•	•	0.0000	0.3927	0.1365	3.00
		Unfilter	1.9000	•	1.0000	•	•	0.0000	•	•	0.0000	0.0610	•	1.00
	Bottom	Filter	•	•	0.0000	•	*	0.0000	0.0120	*	1.0000	•	*	0.00
		Unfilter	1.9000	•	1.0000	*	*	0.0000	0.0043	•	1.0000	0.0920	*	1.00
Cobalt Channel	Surface	Filter	•	•	0.0000	*	*	0.0000	0.0022	0.0026	2.0000	0.3395	0.0643	2.00
		Unfilter	0.3000		2.0000	3.0000	•	1.0000	0.0005	•	1.0000	0.0041	*	1.00
	Bottom	Filter	*	*	0.0000		*	0.0000	•	•	0.0000	*	*	0.00
Bear Bay	Surface	Filter	•	*	0.0000	•	•	0.0000	0.0004	*	1.0000	*	*	0.00
		Unfilter	0.3000	•	1.0000	2.7000	*	1.0000	0.0004	•	1.0000	*	*	0.00
Bear Creek	Surface	Filter	*	•	0.0000	*		0.0000	*	•	0.0000	0.2640	*	1.00
		Unfilter	*	•	0.0000	6.8000	•	1.0000	•	*	0.0000	0.0037	*	1.00
Labine Bay	Surface	Filter	•	*	0.0000	•	*	0.0000	0.0016	•	1.0000	0.2410	0.0360	3.00
		Unfilter	0.7833	1.0889	6.0000	7.5000	4.6357	3.0000	0.0003	0.0001	2.0000	0.0052	0.0055	6.00
Murphy Bay	Surface	Filter	•	•	0.0000	*	•	0.0000	•	•	0.0000		*	0.00
Silver ** Point	Surface	Filter	13.8000	*	1.0000	3.8000	•	1.0009	0.0015	*	1.0000	4.2000	*	1.00
		Unfilter	81.1000	•	1.0000	51.4003	*		0.0018	•	1.0000	5.8000	*	1.00
West Audit	Surface	filter	•	•	0.0090	*	•		*	*	0.0000	*		0.00
		Unfilter	5.5500	7.4346	2.0000	29.7500	30.8177	8.0000	*	*	0.0300	0.1762	0.2472	2.00
Garbage Creek	Surface	Filter	*	*	0.0000	*	•	0.0000	•	•	9.0000	•	*	0.00
		Unfilter	3.0000	•	1.0000	•	*	0.0003	0.0015	*	1.0000	0.0065	*	1.00

• Analysis not done

** Pore water

Eote: Concentrations are only reported if twice the detection limit

TABLE 6c: RADIUM 226, LEAD 210, LEAD AND URANIUM CONCENTRATIONS IN WATER COLLECTED IN 1982 AND 1983

TABLE 7: IRON CONCENTRATIONS IN FILTERED AND UNFILTERED SHORELINE WATER IN 1983

Location	Sample code	Filtered mg/l	Unfiltered mg/l
Bear Bay	3W3	24	24
	3W2	48	86
Cobalt Channel	2W7	61	64
Outer Labine Bay	5W14	29	42
	5W13	60	71
	5W11	64	66
	5W12	32	40
Inner Labine Bay	5W9	45	56
	5W10	33	46
	5W8	145	70
West Adit	9W1	35	107
	9W2	53	53

Another feature related to the wastes and their discharges was the periphytic algal growth on Bear Bay. Extensive algal mats were observed in 1982 and 1983, although the amount of surface seepage from Garbage Lake was very small. Dilution from Bear Creek and Bear Bay water had left indetectable changes in the water quality of Bear Bay. The bloom of periphytic algae was the only evidence of discharge, as no other area investigated on the shoreline along the peninsula exhibited a similar periphytic community (see Appendix C for locations).

The algal mat extended over the entire shoreline of the Bay and may act as an absorbent of metals and radionuclides. Along the Cobalt Channel beach only small patches of algae were noted and remnants of the colonies were found on the bottom of the channel.

Together with the higher primary productivity in Garbage Lake, the periphytic algal mat appeared to be the only other evidence of effects on the aquatic pathway. The algal mat on the beach contained 11.5 pCi/g (dry) of Ra-226 and 23.3 pCi/g (dry) of Pb-210. Based on these concentrations, a maximum dose of 3 rad/h from Ra-226 and 8 rad/h from Pb-210 can be derived. These dosages are about 1000 times below those at which radiological effects on aquatic life have been reported (p.c., D. Lush).

3.4. Water Quality in the Vicinity of the Peninsula

Ice was still floating around the peninsula at the time of sampling in 1983. Temperature, dissolved oxygen and pH profiles were measured and are summarized in detail in Appendix C, for the areas around Cobalt Channel, Cobalt Island, outer LaBine Bay and locations to the north of the Port Radium peninsula. These locations had no thermocline, but the water in inner LaBine Bay was stratified 1 meter below the surface.

A total of 70 water samples from Great Bear Lake were analyzed for metals and other elements in 1982 and 1983 and 19 samples were analyzed for radionuclides. The results have been previously discussed in relation to the waste waters and concentrations along the shoreline (Table 6a - c). It is evident that, compared to concentrations of heavy metals in the water in the vicinity of the peninsula, the water in direct association with some waste sites had elevated concentrations of some elements.

To ascertain the environmental implications of these concentrations, they were compared to water quality objectives. Environment Canada has produced guidelines for the protection of aquatic life and drinking water. These guidelines, published in 1979, have been used in the following evaluation of the concentrations of Pb, U, Ni, Cu, As, Cd and Zn in samples of wastewater and Great Bear Lake water in the vicinty of Port Radium.

The first striking observation is the frequent occurrence of concentrations below the detection limits of the analytical methods. The percentage of water samples from the entire collection of both years for which the concentrations were above the detection limit, ie. at least two times above the detection limit, are given in Table 8.

Since less than 50% of the concentrations of most ofthe metals were undetectable, metal concentrations at or below the detection limits were considered as real values by setting each value at 0.5 of the detection limit.

TABLE 8 : PERCENTAGE OF WATER SAMPLES WITH VALUES ABOVE THE DETECTION LIMIT

Element	Ra-226	Pb-210	Pb	U	Cd	Zn	Co	Ni	Cu	As
%	89	63	18	38	8	63	31	45	23	68

The guideline concentration for each element was subtracted from the value obtained. Hence, if the concentration was above the water quality guideline, a positive value was produced, while a negative value resulted when a concentration was below the guideline (Tables 9a-c).

Ra-226 values were compared with the federal guideline for tailings effluent discharges of 10 pCi/l. In the absence of guideline for Pb-210, the average concentration of two samples of Great Bear Lake water (8.1 pCi/l) was used.

The Ra-226 concentrations (Table 9a), with the exception of the porewater from the Silver Point Tailings, were all below the federal guideline of 10 pCi/l and were below the more stringentguideline of 3.0 pCi/l of the Province of Ontario (Table 6c). The filtered pore water was only 0.8 pCi/l above the federal guideline.

For Pb-210, negative values generally resulted from the calculations, although the concentrations of unfiltered porewater from Silver Point tailings and the seepage from the West Adit tailings area were positive with respect to the aquatic: life guidelines.

The sample size for the metal concentrations was much larger than for radionuclides, with a total of 70 samples. Only one sample from the bottom of Cobalt Channel contained Pb (+0.08 mg/l) above the recommended guideline of 0.005 mg/l (Table 9b and 9c). The average lead concentration of 10 filtered surface samples in Garbage Lake was 0.02 mg/l above the standard. However, the variability in these values was large. For the remaining metals (As, Cd, Zn, U, Ni and Cu), the calculated values were predominantly negative in all locations other than Garbage Lake, West Adit and the porewater extracted from the Silver Point tailings.

Element and Aquatic Life Standard (Env. Can., 1979)			Radium 226 10 pCi/l			Lead 210 8.15 pCi/l			Lead .005 mg/l		
Location	Sample		MEAN	STD DEV	N	MEAN	STD DEV	N	MEAN	V	N
Great Bear Lake											
KO3	Surface	Filter	*	*	0	*	*	0	-0.00	*	1
		Unfilter	*9.95	*	1	-1.35	*	1	-0.00	*	1
KO4	Surface	Filter		*	0	•	*	0	-0.00	*	1
		Unfilter	-9.70	*	1	*1.35		1	-0.00		1
Garbage Lake	Surface	Filter	•	*	0		•	0	0.00	0.03	10
		Unfilter	-8.10	*	1	-7.05	*	1	-0.00	0.00	3
	Bottom	Filter	*		0	•	*	0	0.00	0.01	2
		Unfilter	-8.10	•	1	*6.75		1	-0.00	0.00	2
Cobalt Channel	Surface	Filter	•	•	0		•	0	0.01	0.04	6
		Unfilter	-9.70	0.00	2	*3.95	1.70	2	-0.00	0.00	2
	Bottom	Filter	•	•	0			0	0.08	*	1
Bear Bay	Surface	Filter	*	*	0	•	*	0	0.01	0.03	4
		Unfilter	*9.70	*	1	-5.45	*	1	-0.00	0.00	2
Bear Creek	Surface	Filter			0	•	*	0	-0.00	0.00	3
		Unfilter	-9.95	*	1	*1.35	*	1	-0.00	•	1
Labine Bay	Surface	Filter	•		0			0	-0.00	0.00	13
		Unfilter	-9.22	1.09	0	-2.37	3.70	6	-0.00	0.00	7
Murphy Bay	Surface	Filter	•		0	*		0	-0.00	•	1
Silver Point	Surface	Filter	0.80	*	1	-4.35	*	1	-0.00	*	1
		Unfilter	71.10	*	1	43.25	*	1	-0.00	•	1
West Adit	Surface	Filter		*	0	•		0	-0.00	0.00	2
		Unfilter	*4.45	7.42	2	58.10	21.00	2	-0.00	0.00	2
Garbage Creek	Surface	Filter		*	0		*	0	-0.00	•	1
		Unfilter	-7.00		1	-7.05		1	-0.00	•	1

* Analysis not done

** No lead 210 objectives are available from Environment Canada. Instead, background concentration from Great Bear Lake used.

TABLE 9a: CONCENTRATIONS OF RADIUM 226, LEAD 210 AND LEAD ABOVE OR BELOW THE WATER QUALITY OBJECTIVES FOR PROTECTION OF AQUATIC LIFE

Location	Sample		Uranium .30 mg/l MEAN	STD DEV	N	Nickel .025 mg/l MEAN	STD DEV	N	Copper .002 mg/l MEAN	STD DEV	N
Great Bear Lake KO3	Surface	Filter	*	*	1	-0.02	•	1	-0.00	•	1
		Unfilter	-0.30	•	1	-0.02	*	1	-0.00	•	1
KO4	Surface	Filter	•	•	0	-0.02	*	1	-0.00	•	1
		Unfilter	-0.30	*	1	0.00	*	1	-0.00	•	1
Garbage Lake	Surface	Filter	-0.06	0.18	7	0.03	0.02	10	-0.00	0.00	10
		Unfilter	-0.24	•	1	-0.01	0.02	3	-0.00	0.00	3
	Bottom	Filter	•	*	0	0.01	0.04	2	-0.00	0.00	2
		Unfilter	-0.21	*	1	0.03	0.03	2	0.01	0.01	2
Cobalt Channel	Surface	Filter	-0.08	0.17	4	-0.02	0.01	6	0.00	0.01	6
		Unfilter	-0.30	0.00	2	-0.02	0.00	2	0.02	0.02	2
	Bottom	Filter	-0.30	*	1	-0.02	*	1	-0.00	•	1
Bear Bay	Surface	Filter	-0.21	0.12	2	-0.02	0.00	4	-0.00	0.00	4
		Unfilter	-0.30	*	1	-0.02	0.00	2	-0.00	0.00	2
Bear Creek	Surface	Filter	-0.17	0.19	2	-0.0%	0.01	3	-0.00	0.00	3
		Unfilter	-0.30	•	1	-0.02	*	1	-0.00	•	1
Labine Bay	Surface	Filter	-0.16	0.12	6	-0.02	0.01	13	-0.00	0.00	13
		Unfilter	-0.29	0.01	6	-0.02	0.00	7	-0.00	0.00	7
Murphy Bay	Surface	Filter	-0.30	•	1	-0.02	•	1	-0.00		1
Silver Point	Surface	Filter	3.90	•	1	0.18	•	1	0.21	•	1
		Unfilter	5.50	*	1	0.22	*	1	0.19	•	1
West Adit	Surface	Filter	•	•	0	-0.00	0.03	2	0.03	0.05	2
		Unfilter	-0.12	0.25	2	0.03	0.07	2	0.04	0.05	2
Garbage Creek	Surface	Filter	•	*	0	-0.02	•	1	0.00	•	1
		Unfilter	-0.29	*	1	0.01	*	1	0.00	•	1

Element and Aquatic Life Standards (Env. Can., 1979)

* Analysis not done

TABLE 9b: CONCENTRATIONS OF URANIUM, NICKEL AND COPPER ABOVE OR BELOW THE WATER 'QUALITY OBJECTIVES FOR PROTECTION OF AQUATIC LIFE

Element and Aquatic Standard (Env. Can., 1979)			Arsenic .05 mg/l			Cadmium .0002 mg/l			Zinc .05 mg/l		
Location	Sample		MEAN	STD DEV	N	MEAN	STD DEV	N	MEAN	STD DEV	N
Great Bear Lake											
K03	Surface	Filter	-0.05	*	1.	-0.00	*	1.	-0.02	*	1.
		Unfilter	-0.05	*	1.	-0.00	*	1.	-0.02	*	1.
K04	Surface	Filter	-0.05	*	1.	-0.00	*	1.	-0.02	*	1.
		Unfilter	-0.05	*	1.	-0.00	*	1.	-0.02	*	1.
Garbage Lake	Surface	Filter	0.00	0.01	10.	-0.00	0.00	3.	-0.04	0.01	0.
		Unfilter	0.03	0.02	3.	-0.00	0.00	3.	-0.04	0.00	3.
	Bottom	Filter	0.05	0.13	2.	-0.00	0.00	2.	-0.03	0.00	2.
		Unfilter	0.10	0.20	2.	-0.00	0.00	2.	-0.02	0.00	2.
Cobalt Channel	Surface	Filter	-0.03	0.05	6.	-0.00	0.00	2.	-0.04	0.01	6.
		Unfilter	-0.05	0.01	2.	-0.00	0.00	2.	-0.03	0.02	2.
	Bottom	Filter	-0.05	*	1.	*	*	0.	-0.02	*	1.
Bear Bay	Surface	Filter	-0.04	0.01	4.	-0.00	0.00	2.	-0.03	0.02	4.
		Unfilter	-0.05	0.00	2.	-0.00	0.000	2.	-0.03	0.03	2.
Bear Creek	Surface	Filter	-0.02	0.05	3.	-0.00	*	1.	-0.04	0.01	3.
		Unfilter	-0.05	*	1.	-0.00	*	1.	-0.03	*	1.
Labine Bay	Surface	Filter	-0.02	0.08	13.	-0.00	0.00	7.	-0.03	0.02	13.
		Unfilter	-0.04	0.01	7.	-0.00	0.00	7.	-0.02	0.01	7.
Murphy Bay	Surface	Filter	-0.05	*	1.	*	*	0.	-0.05	*	1.
Silver Point	Surface	Filter	4.15	*	1.	0.00	*	1.	2.35	*	1.
		Unfilter	4.25	*	1.	0.00	*	1.	1.35	*	1.
West Adit	Surface	Filter	3.45	4.95	2.	0.00	0.00	2.	0.07	0.17	2.
		Unfilter	3.80	5.44	2.	0.00	0.00	2.	0.07	0.17	2.
Garbage Creek	Surface	Filter	-0.04	*	1.	-0.00	*	1.	-0.04	*	1.
		Unfilter	-0.03	*	1.	-0.00	*	1.	-0.03	*	1.

* Analysis not done

TABLE 9c: CONCENTRATIONS OF ARSENIC, CADMIUM AND ZINC ABOVE OR BELOW THE WATER QUALITY OBJECTIVES FOR PROTECTION OF AQUATIC LIFE

Location	Sample		Nickel .025 mg/l MEAN	STD DEV	N	Copper 1.0 mg/l MEAN	STD DEV	N	Arsenic .05 mg/l MEAN	STD DEV	N
Great Bear Lake KO3	Surface	Filter	-0.02	*	1	-1.00	•	1	-0.05	•	1
		Unfilter	-0.02	*	1	-1.00	*	1	-0.05	•	1
KO4	Surface	Filter	-0.02	*	1	-1.00	*	1	-0.05	*	1
		Unfilter	0.00	*	1	-1.00	*	1	-0.05	•	1
Garbage Lake	Surface	Filter	0.03	0.02	10	-1.00	0.00	10	0.00	0.01	10
		Unfilter	-0.01	0.02	3	-1.00	0.00	3	0.03	0.02	3
	Bottom	Filter	0.01	0.04	2	-1.00	0.00	2	0.05	0.13	2
		Unfilter	0.03	0.03	2	-0.99	0.01	2	0.10	0.20	2
Cobalt Channel	Surface	Filter	-0.02	0.01	6	-1.00	0.01	6	-0.03	0.05	6
		Unfilter	-0.02	0.00	2	-0.98	0.82	2	-0.05	0.01	2
	Bottom	Filter	-0.02	*	1	-1.00	*	1	-0.05	*	1
Bear	Surface	Filter	-0.02	0.00	4	-1.00	0.00	4	-0.04	0.01	4
		Unfilter	-0.02	0.00	2	-1.00	0.00	2	-0.05	0.00	2
Bear Creek	Surface	Filter	-0.02	0.01	3	-1.00	0.00	3	-0.02	0.05	3
		Unfilter	-0.02	*	1	-1.00	*	1	-0.05	*	1
Labine Bay	Surface	Filter	-0.02	0.01	13	-1.00	0.00	13	-0.02	0.08	1.3
		Unfilter	-0.02	0.00	7	-1.00	0.00	7	-0.04	0.01	7
Murphy Bay	Surface	Filter	-0.02	*	1	-1.00	*	1	-0.05	*	1
Silver Point	Surface	Filter	0.18	*	1	-0.79	*	1	4.15	*	1
		Unfilter	0.22	*	1	-0.81	*	1	4.25		1
West Adit	Surface	Filter	-0.00	0.03	2	-0.95	0.05	2	3.45	4.95	2
		Unfilter	0.03	0.07	2	-0.96	0.05	2	3.80	5.44	2
Garbage Creek	Surface	Filter	-0.02	*	1	-1.00	*	1	-0.04	•	1
		Unfilter	0.01	*	1	-0.99	*	1	-0.03	•	1

Element and Drinking Water Standard (Env. Can., 1979)

* Analysis not done

TABLE 10b: CONCENTRATIONS OF NICKEL, COPPER AND ARSENIC ABOVE OR BELOW THE DRINKING WATER OBJECTIVES

Clement and Drinking Water Standard (Env. Can. 1979)

Location	Sample		Cadmium .005 mg/l MEAN	STD DEV	N	Zinc 5.0 mg/l MEAN	STD DEV	N	Cobalt 1.0 mg/l MEAN	STD DEV	N
Great Bear Lake											
KO3	Surface	Filter	-0.00	*	1	-4.97	*	1	-1.00	*	1
		Unfilter	-0.00	*	1	-4.97	*	1	-1.00	*	1
KO4	Surface	Filter	-0.00	*	1	-4.97	*	1	-1.00	*	1
		Unfilter	-0.00	*	1	-4.97	*	1	-1.00	*	1
Garbage	Surface	Filter	-0.00	0.00	3	-4.99	0.01	10	-1.00	0.00	10
Lake		Unfilter	-0.00	0.00	3	-4.99	0.00	3	-1.00	0.00	3
	Bottom	Filter	-0.00	0.00	2	-4.98	0.00	2	-0.99	0.01	2
		Unfilter	-0.00	0.00	2	-4.97	0.00	2	-0.98	0.02	2
Cobalt	Surface	Filter	-0.00	0.00	2	-4.99	0.01	6	-1.00	0.00	6
Channel		Unfilter	-0.00	0.00	2	-4.98	0.02	2	-1.00	0.00	2
	Bottom	Filter	*	*	0	-4.97	*	1	-1.00	•	1
Bear	Surface	Filter	-0.00	0.00	2	-4.98	0.02	4	-1.00	0.00	4
Bay		Unfilter	-0.00	0.00	2	-4.98	0.03	2	-1.00	0.00	2
Bear	Surface	Filter	-0.00	*	1	-4.99	0.01	3	-1.00	0.00	3
Creek		Unfilter	-0.00	*	1	-4.98	*	1	-1.00	*	1
Labine	Surface	Filter	-0.09	0.00	7	-4.95	0.0%	13	-0.99	0.01	13
Bay		Unfilter	-0.00	0.00	7	-4.97	0.01	7	-1.00	0.00	7
Murphy Bay	Surface	Filter	*	*	0	-5.00	*	1	-1.00	*	1
Silver	Surface	Filter	-0.00	*	1	-2.60	*	1	6.20	*	1
Point		Unfilter	-0.09	*	1	-3.60	*	1	5.20	*	1
West	Surface	Filter	-0.00	0.00	2	-4.88	0.17	2	-0.63	0.51	2
Adit		Unfilter	-0.00	0.00	2	-4.88	0.17	2	-0.63	0.52	2
Garbage	Surface	Filter	-0.00	*	1	-4.99	*	1	-1.00	*	1
Creek		Unfilter	-0.00	•	1	-4.98	*	1	-0.99	•	1

* Analysis not done

TABLE 10c: CONCENTRATIONS OF CADMIUM, ZINC AND COBALT ABOVE OR BELOW THE DRINKING WATER OBJECTIVES

When the same calculations were made with respect t drinking water objectives, the results did not change significantly (Tables 10a, b and c). It may be self-evident that the water of Garbage Lake along with the melt water from West Adit and the Silver Point tailings porewater, did not qualify as drinking water.

4.0 CONCLUSIONS

Perceived and realistic concerns over environmental problems related to uranium mill tailings dictated the need to identify the location of uranium mill tailings on and around the Port Radium peninsula. Milling records indicated that approximately one million tons of uranium tailings exist in the area.

It is concluded that the wastes on land related to the uranium mining and milling era are located in the West Adit area and in Murphy and Radium Lakes. Most of the tailings, were either carried as slurries down steep slopes above the West Adit tailings area or via Murphy Creek into Great Bear Lake.

Because most of the tailings are submerged in Great Bear Lake, radon emanationshould be curtailed and acid generation appeared to be suppressed. In contrast to the weakly acid generating tailings on land in the West Adit tailings area, the tailings recovered from a depth of 13 m from Murphy Bay were alkaline. The pH of sediments in this area likely remain unchanged as microbial acid generation at the low temperatures and oxygen concentrations recorded in the lake is likely inhibited.

Johnson (1966 and 1975) suggested, based on extensive studies of Great Bear Lake, that the water below 100 m does not mix with the surface water. Therefore, even if acid generation did occur in the sediments deep in Great Bear Lake, surface water would not be contaminated.

Although one million tons of uranium tailings were discharged on, but primarily around, the Port Radium peninsula, based on the results of parameters measured in this study, these tailings have left little effect on the surrounding Great Bear Lake water. In retrospect, Lake disposal appears to have been an acceptable solution for uranium mill tailings disposal at Port Radium, since dumping such a large quantity of tailings on land would likely have produced considerably greater problems.

The potential for problems with land-based tailings material is shown in the West Adit Tailings Area. Fortunately, this area is very small and seepage occurs only for a short time during the year. Not only are the concentrations of contaminants in the West Adit melt water high, but in addition, a survey of the Port Radium area carried out in 1983 by the Mining Inspection Services (S. Wong, File 204-06, 1983) detected sources of high gamma radiation in the vicinity. Some remedial is required at this site.

The tailings in Murphy Creek , Murphy Lake and Radium Lake are either dry or covered with waste rock and contained in depressions from which surface seepage was not apparent. Since the covers will reduce oxygen penetration, acid generation is likely curtailed.

The chemical composition of silver tailings on Silver Point, and of sediments in Cobalt Channel, LaBine Bay and Garbage Lake was distinctly different from that of sediments in Murphy Bay and West Adit tailings. The estimated half-million tons of silver tailings were alkaline, and did not produce acid. In the waterlogged area of the Silver Point tailings, high concentrations of metals and radionuclides were detected. These results lead to the conclusion that disturbing or moving these tailings could produce greater contamination of Great Bear Lake.

The water quality of Great Bear Lake in the vicinity of Port Radium did not appear to have changed since the mine shut down in 1982. In LaBine Bay and Cobalt Channel, no chemocline was found to exist above the sediment. It can be concluded that the water quality around Port Radium is not presently affected by the discharges from either uranium or silver mining.

Evidence of a localized source of contamination was found in water in contact with the waste rock causeway, built with gangue from the Eldorado mine. Weathering of this waste rock is probably releasing metals, particularly cobalt, as the ore is rich in this metal. Since the exposed portion of the waste rock along the causeway is very small, the environmental effects of this release are likely small, due to the enormous diluting capacity of Great Bear Lake. The same argument may be used for the water in contact with the Silver Point tailings beach, supported by the lack of appreciable change in the water quality of Cobalt Channel.

In Garbage Lake, the concentrations of most metals were below the guidelines for the protection of aquatic life. Since the solubility of most heavy metals in alkaline systems is low, changes in the water quality are unlikely to occur with these tailings. The high primary productivity in Garbage

Lake indicated that the water supported phytoplankton. As long as the present conditions in Garbage Lake remain unchanged (anoxic sediments and stratified water column), it can be expected that discharges from Garbage Lake will have no effectson Great Bear Lake than to promote some algal growth in Bear Bay. Because Ra-226 and Pb-210 had not accumulated in this growth, the potential for transfer of these radionuclides to the aquatic pathway appears low. If the water level of Garbage Lake drops, exposing the tailings to dessication, it is likely that the fine surface tailings would be dispersed by wind.

In conclusion, the assessment of the environmental implications of all waste sites on the peninsula and in the surrounding waters revealed that, although 1.5 million tons of silver and uranium tailings are in close contact with Great Bear Lake water, environmental problems were not evident.

5.0 RECOMMENDATIONS

1. The seepage from the West Adit area should be neutralized and the area covered in order to reduce oxygen penetration, and thus acid generation.

2. The Silver Point tailings should remain in their present location, and restoration or stabilization is not warranted since no deterioration of water quality has been noted. Alterations of the site may only result in contamination.

3. As the present conditions of Garbage lake are environmentally acceptable, monitoring of the water level and of the oxygen profile should be performed annually.

6.0 REFERENCES

Bennett, R., Echo Bay Mines Ltd., personal communication.

Chambers, H., "Report: Field Trip to Echo Bay Mines, Port Radium." Environmental Protection Service, Department of Energy, Mines and Resources, May 22-25, 1973.

DIAND, Mineral Resources Branch, Department of Energy, Mines and Resources, Ottawa. Reference AG1.

Environment Canada, "Water Quality Sourcebook. A Guide to Water Quality Parameters." by R.N. McNeely, V.P. Neimanis and L. Dwyer. Inland Waters Directorate, Water Quality Branch, Ottawa, Canada, 1979.

Ministry of the Environment, "Guidelines for Surface Water Quality. Volume 1: Inorganic Substances." S.W. Reeder (ed.). Inland Waters Directorate, Water Quality Branch, Environment Canada, 1979.

Griffith, J.W., "Chapter 4: Northwest Territories -Eldorado Mining and Refining Limited (Port Radium Mine)." IN: The Uranium Industry - Its History, Technology and Prospects. Department of Energy, Mines and Resources, Mineral Resources Division, Mineral Report 12, Ottawa, 1967.

Hoffman, R.R., "Eldorado Mining and Refining Port Radium, NWT." IN: The Milling of Canadian Ores, 6th Commonwealth Mining and Metallurgical Congress, 1957.

Joe, E., Senior Industrial Research Officer for Mineral Sciences Laboratory, Dept. of Energy, Mines and Resources, CANMET, personal communication.

Johnson, L., "Temperature of Maximum Density of Fresh Water and its Effect on Circulation in Great Bear Lake." J. Fish. Res. Board Canada, 23(7): 963973, 1966.

Johnson, L., "Distribution of Fish Species in Great Bear Lake, NWT, with reference to Zooplankton, Benthic Invertebrates, and Environmental Conditions." J. Fish. Res. Board Canada, 32:1989-2004, 1975.

Johnson, L., "Physical and chemical characteristics of Great Bear Lake, Northwest Territories." J. Fish. Res. Board Canada, 32:1971-1987, 1975.

Kalin, M., "Identification of Potential Environmental Problems at Port Radium. Field Report: In search of uranium. mill tailings." Submitted to: Environmental Protection Service, Environment Canada, Yellowknife, NWT, in fulfillment of Contract No. 0183, 1982.

Kalin, M., "Long-term Ecological behavior of Abandoned Uranium Mill Tailings. 1. Synoptic Survey and Identification of Invading Biota." Environment Canada, Atomic Energy Control Board, and Energy, Mines and Resources Canada, 1982.

Kalin, M., Port Radium: An Environmental Survey of Mining Wastes. Environmental Protection Service, Environment Canada, 1983.

Lendrum, C., Clyde Lendrum Consulting, King City, Ontario, personal communication.

Lush, D., Environmentalist, Beak Consultants Limited, Mississauga, Ontario, personal communication.

Moore, J.W. and D.J. Sutherland, "Distribution of Heavy Metals and Radionuclides in Sediments, Water and Fish in an Area of Great Bear Lake Contaminated with Mine Wastes." Arch. Environ. Contam. Toxicol., 10:329-338, 1981.

Redshaw, A.G., "Correspondence re: Summaries of Water Quality Data from Operating Mines." Indian and Northern Affairs, Yellowknife, NWT, 1974.

Roy, M. and S. Vezina, "Studies of Mine Waste Containment at Mining Sites on Great Bear Lake." ALUR 1972-73, Indian Affairs and Northern Development, DIAND Pub. No. OS-3039-000-EE-A1, 1973.

Statistical Analysis System 82.3, SAS Institute Inc., Cary, North Carolina, U.S.A.

Sutherland, D.J., Environmental Protection Service, Environment Canada, Yellowknife, NWT, personal communication, 1983.

Wilson, J.B., Environmental Protection Service, Environment Canada, Yellowknife, NWT, personal communication, 1983.

Wong, S., Report on Radiation Safety - Port Radium, Government of Northwest Territories, Justice and Public Services, 1983.

Zigarlick, S., Echo Bay Mines Ltd., Edmonton, Alberta, personal communication.

Wollett, G., "The Eldorado Mine and the Echo Bay Group.",Presented at the 1972 Exploration Symposium, Yellowknife, NWT, 1972.

TABLE OF CONTENTS

APPENDICES

APPENDIX A

DATA SUMMARIES, DUMPS AND LISTINGS PORT RADIUM AND RAYROCK

Section A1 Water summaries

Section A2 Water dumps

Section A3 Solids summaries

Section A4 Solids dumps

Section A5 Data listing of Rayrock

APPENDIX A

DATA SUMMARIES AND LISTINGS

SAS

			pH			CONDO		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	7.80	.	1.00	100.00	.	1.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	7.60	.	1.00	120.00	.	1.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	7.70	.	1.00	120.00	.	1.00
GARBAGE LAKE	SURFACE WATER	FILTER	8.21	0.13	7.00	345.71	5.35	7.00
		UNFILTER	8.20	0.00	3.00	260.00	0.00	3.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	8.20	0.00	2.00	400.00	0.00	2.00
COBALT CHANNEL	SURFACE WATER	FILTER	8.30	0.08	4.00	132.50	17.08	4.00
		UNFILTER	7.30	0.71	2.00	125.00	7.07	2.00
	BOTTOM WATER	FILTER	8.20	.	1.00	180.00	.	1.00
BEAR BAY	SURFACE WATER	FILTER	8.90	0.57	2.00	160.00	42.43	2.00
		UNFILTER	7.80	0.00	2.00	120.00	0.00	2.00
BEAR CREEK	SURFACE WATER	FILTER	7.10	0.14	2.00	115.00	7.07	2.00
		UNFILTER		.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	7.53	0.86	6.00	118.33	22.06	6.00
		UNFILTER	7.62	0.20	6.00	125.00	22.36	6.00
MURPHY BAY	SURFACE WATER	FILTER	8.20	.	1.00	130.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	7.50	*	1.00	3600.00	.	1.00
		UNFILTER	7.50	.	1.00	3600.00	.	1.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	7.20	0.28	2.00	435.00	445.48	2.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA

			CRA			DRA		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	0.00	.	1.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.30	.	1.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	1.90	.	1.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	1.90	.	1.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.30	0.30	2.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.30	.	1.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	0.00	.	1.00
LABINE BAY	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.78	1.09	5.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	10.80	.	1.00	.	.	0.00
		UNFILTER	81.10	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	5.55	7.42	2.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	3.00	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA

			CPB210			DPB210		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPLE	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	6.80	.	1.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	9.50	.	1.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	1.10	.	1.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	1.40	.	1.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	3.00	.	1.00	0.00	.	1.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	2.70	.	1.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	6.80	.	1.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	5.97	4.86	4.00	0.00	0.00	2.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	3.80	.	1.00	.	.	0.00
		UNFILTER	51.40	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	66.25	21.00	2.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	1.10	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH

			CTH			DTH		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	.	*	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	*	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.04	0.03	3.00	0.00	0.00	4.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	*	.	0.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.0*	0.01	2.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	0.00	*	1.00
BEAR BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	0.02	.	1.00	0.00	.	1.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.02	.	1.00	0.00	0.00	5.00
		UNFILTER	.	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	*	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	*	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
SUBLOC	SAMPID	TEXTURE						
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	*	.	0.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA

SUBLOC	SAMPID	TEXTURE	CU MEAN	CU STD	CU N	DU MEAN	DU STD	DU N
GREAT BEAR LAKE	SURFACE WATER	FILTER	0.25	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.00	.	1.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.00	.	1.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.28	0.16	6.00	0.00	.	1.00
		UNFILTER	0.06	.	1.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.09	.	1.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.29	0.10	3.00	0.00	.	1.00
		UNFILTER	0.00	0.00	2.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	0.00	.	1.00
BEAR BAY	SURFACE WATER	FILTER	0.17	.	1.00	0.00	.	1.00
		UNFILTER	0.00	.	1.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	0.26	.	1.00	0.00	.	1.00
		UNFILTER	0.00	.	1.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.21	0.07	4.00	0.00	0.00	2.00
		UNFILTER	0.01	0.01	6.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	4.20	.	1.00	.	.	0.00
		UNFILTER	5.80	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.18	0.25	2.00	.	.	0.00

SUBLOC	SAMPID	TEXTURE	CU MEAN	CU STD	CU N	DU MEAN	DU STD	DU N
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	0.01	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA   16:29 TUESDAY, MARCH 6,

			CAS			DAS		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
K04	SURFACE WATER	FILTER	0.00	.	1.00	.	.	0.00
		UNFILTER	0.00	.	1.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.05	0.01	10.00	.	.	0.00
		UNFILTER	0.08	0.02	3.00	.	.	0.00
	BOTTOM WATER	FILTER	0.10	0.13	2.00	.	.	0.00
		UNFILTER	0.15	0.20	2.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.06	0.08	2.00	0.00	0.00	4.00
		UNFILTER	0.01	.	1.00	0.00	.	1.00
	BOTTOM WATER	FILTER	.	.	0.00	0.00	.	1.00
BEAR BAY	SURFACE WATER	FILTER	0.01	0.01	2.00	0.00	0.00	2.00
		UNFILTER	0.00	.	1.00	0.00	.	1.00
BEAR CREEK	SURFACE WATER	FILTER	0.04	0.05	2.00	0.00	.	1.00
		UNFILTER	0.00	.	1.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.06	0.09	8.00	0.00	0.00	5.00
		UNFILTER	0.01	0.02	5.00	0.00	0.00	2.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	4.20	.	1.00	.	.	0.00
		UNFILTER	4.30	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	3.50	4.95	2.00	.	.	0.00
		UNFILTER	3.85	5.44	2.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	0.01	.	1.00	.	.	0.00
		UNFILTER	0.02	.	1.00	.	.	0.00

PODIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:20 TUESDAY, MARCH 6,

			CCD			DCD		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
K04	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.00	.	1.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	0.00	0.00	3.00
	BOTTOM WATER	FILTER	.	.	0.00	0.00	0.00	2.00
		UNFILTER	0.00	.	1.00	0.00	.	1.00
COBALT CHANNEL	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	0.00	0.00	2.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	0.00	0.00	2.00
BEAR CREEK	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
LABINE BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	7.00
		UNFILTER	.	.	0.00	0.00	0.00	7.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	0.00	.	1.00	.	.	0.00
		UNFILTER	0.00	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	0.00	0.00	2.00	.	.	0.00
		UNFILTER	0.10	0.00	2.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6

			CCU			DCU		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
K04	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.00	0.00	3.00	0.00	0.00	7.00
		UNFILTER	0.00	0.00	2.00	0.00	.	1.00
	BOTTOM WATER	FILTER	0.00	0.00	2.00	.	.	0.00
		UNFILTER	0.01	0.01	2.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.02	.	1.00	0.00	0.00	5.00
		UNFILTER	0.03	.	1.00	0.00	.	1.00
	BOTTOM WATER	FILTER	.	.	0.00	0.00	.	1.00
BEAR BAY	SURFACE WATER	FILTER	0.00	.	1.00	0.00	0.00	3.00
		UNFILTER	0.00	.	1.00	0.00	.	1.00
BEAR CREEK	SURFACE WATER	FILTER	0.00	.	1.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	0.00	.	1.00
LABINE BAY	SURFACE WATER	FILTER	0.00	0.00	3.00	0.00	0.00	10.00
		UNFILTER	0.00	0.00	2.00	0.00	0.00	5.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	0.21	.	1.00	.	.	0.00
		UNFILTER	0.19	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	0.07	.	1.00	0.00	.	1.00
		UNFILTER	0.08	.	1.00	0.00	.	1.00
GARBAGE CREEK	SURFACE WATER	FILTER	0.00	.	1.00	.	.	0.00
		UNFILTER	0.01	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6,

SUBLOC	SAMPID	TEXTURE	CCO MEAN	CCO STD	CCO N	DCO MEAN	DCO STD	DCO N
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
K04	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.00	0.00	3.00	0.00	0.00	7.00
		UNFILTER	0.00	0.00	3.00	.	.	0.00
	BOTTOM WATER	FILTER	0.01	0.01	2.00	.	.	0.00
		UNFILTER	0.02	0.02	2.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.00	.	1.00	0.00	0.00	5.00
		UNFILTER	0.00	.	1.00	0.00	.	1.00
	BOTTOM WATER	FILTER	.	.	0.00	0.00	.	1.00
BEAR BAY	SURFACE WATER	FILTER	0.00	.	1.00	0.00	0.00	3.00
		UNFILTER	0.00	.	1.00	0.00	.	1.00
BEAR CREEK	SURFACE WATER	FILTER	0.00	.	1.00	0.00	0.00	2.00
		UNFILTER	0.00	.	1.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.01	0.01	9.00	0.00	0.00	4.00
		UNFILTER	0.00	0.00	5.00	0.00	0.00	2.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	7.20	.	1.00	.	.	0.00
		UNFILTER	6.20	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	0.37	0.51	2.00	.	.	0.00
		UNFILTER	0.37	0.52	2.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	0.00	.	1.00	.	.	0.00
		UNFILTER	0.01	.	1.00	.	.	0.00

FOLT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6,

			CNI			DNI		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
K04	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	0.03	.	1.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.06	0.02	10.00	.	.	0.00
		UNFILTER	0.01	0.02	3.00	.	.	0.00
	BOTTOM WATER	FILTER	0.04	0.04	2.00	.	.	0.00
		UNFILTER	0.05	0.03	2.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.03	.	1.00	0.00	0.00	5.00
		UNFILTER	.	.	0.00	0.00	0.00	2.00
	BOTTOM WATER	FILTER	.	.	0.00	0.00	.	1.00
BEAR BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	4.00
		UNFILTER	.	.	0.00	0.00	0.00	2.00
BEAR CREEK	SURFACE WATER	FILTER	0.02	.	1.00	0.00	0.00	2.00
		UNFILTER	0.00	.	1.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.01	0.01	4.00	0.00	0.00	9.00
		UNFILTER	0.00	0.00	3.00	0.00	0.00	4.00
MURPH. BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	0.21	.	1.00	.	.	0.00
		UNFILTER	0.25	.	1.00	.	.	0.00
WEST AUDI.	SURFACE WATER	FILTER	0.05	.	1.00	0.00	.	1.00
		UNFILTER	0.10	.	1.00	0.00	.	1.00
GARBAGE CREEK	SURFACE WATER	FILTER	0.01	.	1.00	.	.	0.00
		UNFILTER	0.04	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6.

SUBLOC	SAMPID	TEXTURE	CPB MEAN	CPB STD	CPB N	DPB MEAN	DPB STD	DPB N
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
K04	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	.	.	0.00	0.00	.	1.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.04	0.06	2.00	0.00	0.00	8.00
		UNFILTER	.	.	0.00	0.00	0.00	3.00
	BOTTOM WATER	FILTER	0.01	.	1.00	0.00	.	1.00
		UNFILTER	0.00	0.00	2.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.03	0.05	3.00	0.00	0.00	3.00
		UNFILTER	0.00	.	1.00	0.00	.	1.00
	BOTTOM WATER	FILTER	0.09	.	1.00	.	.	0.00
BEAR BA	SURFACE WATER	FILTER	0.03	0.04	2.00	0.00	0.00	2.00
		UNFILTER	0.00	.	1.00	0.00	.	1.00
BEAR CREEK	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	3.00
		UNFILTER	.	.	0.00	0.00	.	1.00
LABINE BAY	SURFACE WATER	FILTER	0.00	.	1.00	0.00	0.00	12.00
		UNFILTER	0.00	0.00	2.00	0.00	0.00	5.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	0.00	.	1.00	.	.	0.00
		UNFILTER	0.00	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	0.00	0.00	2.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
		UNFILTER	0.00	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA   16:29 TUESDAY, MARCH 6.

			CZN			DZN		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	0.03	.	1.00	.	.	0.00
		UNFILTER	0.03	.	1.00	.	.	0.00
K04	SURFACE WATER	FILTER	0.03	.	1.00	.	.	0.00
		UNFILTER	0.03	.	1.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.01	0.00	5.00	0.00	0.00	5.00
		UNFILTER	0.01	0.00	3.00	.	.	0.00
	BOTTOM WATER	FILTER	0.02	0.00	2.00	.	.	0.00
		UNFILTER	0.03	0.00	2.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.04	.	1.00	0.00	0.00	5.00
		UNFILTER	0.04	.	1.00	0.00	.	1.00
	BOTTOM WATER	FILTER	0.03	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	0.03	0.02	3.00	0 0	.	1.00
		UNFILTER	0.08	.	1.00	0.00	.	1.00
BEAR CREEK	SURFACE WATER	FILTER	0.01	0.00	2.00	0.00	.	1.00
		UNFILTER	0.02	.	1.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.03	0.01	7.00	0.00	0.00	6.00
		UNFILTER	0.03	0.01	7.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	2.40	.	1.00	.	.	0.00
		UNFILTER	1.40	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	0.2*	.	1.00	0.00	.	1.00
		UNFILTER	0.2*	.	1.00	0.00	.	1.00
GARBAGE CREEK	SURFACE WATER	FILTER	0.01	.	1.00	.	.	0.00
		UNFILTER	0.02	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA   16:29 TUESDAY, MARCH 6

			CAL			DAL		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	0.11	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	*	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.38	0.32	7.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	*	0.00
CO ALT CH NNEL	SURFACE WATER	FILTER	0.34	0.37	4.00	.	*	0.00
		UNFILTER	.	.	0.00	.	*	0.00
	BOTTOM WATER	FILTER	0.93	.	1.00	.	*	0.00
BEAR BAY	SURFACE WATER	FILTER	0.60	0.71	2.00	*	*	0.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	0.10	0.05	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.12	0.03	6.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	0.06	*	1.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
WEST AUDIH	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

FORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6

SUBLOC	SAMPID	TEXTURE	CMG MEAN	CMG STD	CMG N	DMG MEAN	DMG STD	DMG N
GREAT BEAR LAKE	SURFACE WATER	FILTER	7.9[illegible]	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	0.0[illegible]	.	1.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	14.95	0.26	7.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	7.74	0.20	4.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	7.83	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	9.30	2.16	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	7.63	0.60	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	6.59	2.91	7.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.[illegible]
SILVER POINT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.[illegible]
		UNFILTER	.	.	0.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6

SUBLOC	SAMPID	TEXTURE	CMN MEAN	CMN STD	CMN N	DMN MEAN	DMN STD	DMN N
GREAT BEAR LAKE	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.01	0.01	5.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.01	.	1.00	0.00	0.00	3.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	0.19	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	0.00	6.00
		UNFILTER	.	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	0.02	.	1.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6,

			CCA			DCA		
SUBLOC	SAMPID	TEXTURE	MEAN	STD	N	MEAN	STD	N
GREAT BEAR LAKE	SURFACE WATER	FILTER	17.21	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	34.38	0.64	7.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	16.79	0.58	4.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	16.72	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	22.48	7.22	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	22.75	0.36	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	16.53	0.71	6.00	.	.	0.00
		UNFILTER	*	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	16.41	.	1.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	*	*	0.00	.	*	0.00
		UNFILTER	*	*	0.00	*	*	0.00
WEST AUDIT	SURFACE WATER	FILTER	*	*	0.00	*	*	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

			CFE			DFE		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	0.01	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	0.05	.	1.00	.	.	0.00
		UNFILTER	0.07	.	1.00	.	.	0.00
K04	SURFACE WATER	FILTER	0.04	.	1.00	.	.	0.00
		UNFILTER	0.05	.	1.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.04	0.04	6.00	0.00	0.00	4.00
		UNFILTER	0.06	0.01	3.00	.	.	0.00
	BOTTOM WATER	FILTER	0.57	0.75	2.00	.	.	0.00
		UNFILTER	1.74	2.39	2.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.05	0.02	2.00	0.00	0.00	4.00
		UNFILTER	0.06	.	1.00	0.00	.	1.00
	BOTTOM WATER	FILTER	0.39	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	0.03	0.02	3.00	0.00	.	1.00
		UNFILTER	0.05	0.04	2.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	0.02	.	1.00	0.00	0.00	2.00
		UNFILTER	.	.	0.00	0.00	.	1.00
LABINE BAY	SURFACE WATER	FILTER	0.05	0.04	8.00	0.00	0.00	5.00
		UNFILTER	0.06	0.01	7.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	.	.	0.00	0.00	.	1.00
SILVER POINT	SURFACE WATER	FILTER	0.33	.	1.00	.	.	0.00
		UNFILTER	0.39	.	1.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	0.04	0.01	2.00	.	.	0.00
		UNFILTER	0.08	0.04	2.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	0.08	.	1.00	.	.	0.00
		UNFILTER	0.48	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 198_ WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6,

			CVA			DVA		
			MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPID	TEXTURE						
GREAT BEAR LAKE	SURFACE WATER	FILTER	0.01	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.01	0.00	6.00	0.00	.	1.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.01	0.00	3.00	0.00	.	1.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	0.01	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	0.01	0.00	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	0.01	0.00	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.01	0.00	6.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	0.01	.	1.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

SUBLOC	SAMPID	TEXTURE	CBA MEAN	CBA STD	CBA N	DBA MEAN	DBA STD	DBA N
GREAT BEAR LAKE	SURFACE WATER	FILTER	0.04	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	*	0.00	.	.	0.00
		UNFILTER	.	*	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	*	0.00	.	.	0.00
		UNFILTER	.	*	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	0.14	0.01	7.00	.	.	0.00
		UNFILTER	.	*	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	*	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	0.03	0.01	4.00	.	.	0.00
		UNFILTER	.	*	0.00	.	.	0.00
	BOTTOM WATER	FILTER	0.06	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	0.08	0.06	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	0.05	0.04	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	0.04	0.01	6.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	0.03	.	1.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 AND 1983 WATER SAMPLE DATA 16:29 TUESDAY, MARCH 6.

SUBLOC	SAMPID	TEXTURE	CSI MEAN	CSI STD	CSI N	DSI MEAN	DSI STD	DSI N
GREAT BEAR LAKE	SURFACE WATER	FILTER	1.18	.	1.00	.	.	0.00
K03	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
K04	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE LAKE	SURFACE WATER	FILTER	1.64	0.23	7.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
COBALT CHANNEL	SURFACE WATER	FILTER	1.31	0.20	4.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
	BOTTOM WATER	FILTER	1.71	.	1.00	.	.	0.00
BEAR BAY	SURFACE WATER	FILTER	1.72	0.27	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
BEAR CREEK	SURFACE WATER	FILTER	0.97	0.25	2.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
LABINE BAY	SURFACE WATER	FILTER	1.42	0.51	6.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
MURPHY BAY	SURFACE WATER	FILTER	1.14	.	1.00	.	.	0.00
SILVER POINT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
WEST AUDIT	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00
GARBAGE CREEK	SURFACE WATER	FILTER	.	.	0.00	.	.	0.00
		UNFILTER	.	.	0.00	.	.	0.00

Page

Section A2 Data Dump of Port Radium Waters

Description of rater data.

Variable	Description	Unit	1982 Lab	1982 Det. Limit	1983 Lab	1983 Det. Limit
OBS	Observation	na	na	na	na	na
SITE	Site: Control (K), Port Radium (R)	na	na	na	na	na
AREA	Area within site	na	na	na	na	na
AMEND	Type of amendment of site	na	na	na	na	na
SAMPTYPE	General sample type	na	na	na	na	na
SAMPID	Depth: Description of sample taken	na	na	na	na	na
RNUM	Replicate number	na	na	na	na	na
PH	pH	$-\log [H^+]$	field	na	na	na
CONDO	Conductivity	μmhos/cm	field	na	na	na
CRA	Concentration of radium	pCi/l	nd	nd	SRC	1.1
ERA	Error in concentration	pCi/l	nd	na	SRC	na
CPB210	Concentration of Pb210	pCi/l	nd	nd	SRC	.11
EPB210	Error in concentration of Pb-210	pCi/l	nd	nd	SRC	na
CPB	Pb concentration	mg/l	ICP[1]	.05	DIAND	.0001
CNI	Ni concentration	mg/l	ICP	.014	DIAND	.001
CCU	CU concentration	mg/l	ICP	.002	DIAND	.001
CCO	CO concentration	mg/l	ICP	.0W	DIAND	.001

Description of water data.

Variable	Description	Unit	1982 Lab	1982 Det. Limit	1983 Lab	1983 Det. Limit
CU	U concentration, above detection limit	mg/l	ICP	.10	SRC	.0005
CBA	Ba concentration, above detection limit	mg/l	ICP	.0003	nd	nd
CMG	Mg concentration, above detection limit	mg/l	ICP	.014	nd	nd
CVA	Va concentration, above detection limit	mg/l	ICP	.002	nd	nd
CAL	Al concentration, above detection limit	mg/l	ICP	.016	nd	nd
CMN	Mn concentration, above detection limit	mg/l	ICP	.0006	nd	nd
CCA	Ca concentration, above detection limit	mg/l	ICP	.001	nd	nd
DATE	Year of sampling	na	na	na	na	na
SUBAREA	Subarea	na	na	na	na	na
TEXTURE	Filter / Non-filtered	na	na	na	na	na
CAS	As concen- Won	mg/l	ICP	.08	DIAND	.001
CCD	Cd concen- Won	mg/l	nd	nd	DIAND	.00005
CFE	Fe concen- Won	mg/l	ICP	.001	DIAND	.005

Description of water data

Variable	Description	Unit	1982 Lab	1982 Det. Limit	1983 Lab	1983 Det. Limit
CZN	Zn concentration	mg/l	ICP	.004	DIAND	.005
CTH	Th concentration	mg/l	ICP	.011	nd	nd
CSI	Si concentration	mg/l	ICP	.002	nd	nd
SUBLOC	Site /Area	na	na	na	na	na
DRA	Instance of Ra concentration < D.L.	0= incident	nd	nd	SRC	1.1
DPB210	Instance of Pb-210 concentration < D.L.	0= incident	nd	nd	SRC	.11
DPB	Instance of Pb concentration < D.L.	0= incident	ICP	.05	DUND	.0001
DNI	Instance of Ni concentration < D.L.	0= incident	ICP	.014	DUND	.001
DCU	Instance of Ci concentration < D.L.	0= incident	ICP	.002	DUND	.001
3CO	Instance of Co concentration < D.L.	0= incident	ICP	.003	DUND	.001
DU	Instance of U concentration < D.L.	0= incident	ICP	.10	SRC	.0005
DBA	Instance of Ba concentration < D.L.	0= incident	ICP	.0003	nd	nd
DMG	Instance of Mg concentration < D.L.	0= incident	ICP	.014	nd	nd
DVA	Instance of Va concentration < D.L.	0= incident	ICP	.002	nd	nd
DAL	Instance of Al concentration < D.L.	0= incident	ICP	.016	nd	nd

Description of water data

Variable	Description	Unit	Lab	1982 Det. Limit	Lab	1983 Det. Limit
DMN	Instance of Mn concentration<D.L.	0= incident	ICP	.0006	nd	nd
DCA	Instance of Ca concentration<D.L.	0= incident	ICP	.001	nd	nd
DAS	Instance of As concentration<D.L.	0= incident	ICP	.002	DUND	.001
DCD	Instance of Cd concentration < D.L.	0= incident	nd	nd	DUND	.00005
DFE	Instance of Fe concentration < D.L.	0= incident	ICP	.001	DIAND	.005
DZN	Instance of Zn concentration<D.L.	0= incident	ICP	.004	DUND	.005
DTH	Instance of Th concentration<D.L.	0= incident	ICP	.011	nd	nd
DSI	Instance of Si concentration < D.L.	0= incident	ICP	.002	nd	nd

Description of water data

Variable	Description	Unit	Lab	1982 Det. Limit	Lab	1983 Det. Limit

DIAND = Department of Indian Affairs and Northern Development
SRC = Saskatchewan Research Council

na = not available
nd = not done
ICP = Inductively Coupled Plasma Laboratory, University of Toronto

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAREA	4HENO	SAMPTYPE	SAMPIO	RNUM	PH	CUNOO	MOIST	LUI	CRA	ERA	CPB210	EPB210	CPB	CNI	CCU	CCO	CCO2	ECO2	CC2COE
1	K	01	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	7.3	100	.	.	.	.	.	.	.	.			.	.	.
2	K	03	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	.		.	.	.	2
3	K	03	N	.	.	.	NC AMENDMENT	WATER	SJUFACE WATER	.	7.6	120	.	.	.	.	6.8	.	.	.	.	.	.	.	2
4	K	04	N	.	.	.	NU AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
5	K	04	N	.	.	.	NO AMENCMENT	WATER	SURFACE WATER	.	7.7	120	.	.	.	.	9.5	.	.	0.0260	.		.	.	2
b	P	01	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	0.0350	0.0022	0.0019	.	.	2
7	H	01	N	.	.	.	NU AMENDMENT	WATER	SUFFACE WATER	.	.	.	.	.	.	.	.	.	0.0002	0.0390	0.0021	0.0020	.	.	2
[redacted]	[redacted]	31	.	.	.	.	NO ANENCMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	0.0380	0.0023	0.0030	.	.	2
9	R	01	N	.	.	.	NU AMENCMENT	WATER	SUFFACE YATER	.	8.5	350	.	.	.	.	.	.	.	0.CECC	.		.	.	.

OBS	CU	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE	CNA	ENA	NACODE	CVA	EVA	V4CODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE
1	0.2490	.	1	.	.	.	0.04	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.98	.	1	.	.	.	0.01	.	1	0.11	.	1	.	.	3	.	.	.	17.21	.	1
2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
3	0.0013	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
4	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	.	0.02	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
5	0.0016	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
6	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
7	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
8	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
9	0.1280	.	1	.	.	.	0.13	.	1	.	.	.	.	.	.	.	.	.	.	.	.	14.83	.	1	.	.	.	0.01	.	1	0.10	.	1	.	.	0	.	.	.	33.96	.	1

OBS	DATE	SUBAREA	TEXTURE	CAS	CCD	CFE	CZN	CTH	CCR	CSI	CAG	CAU	SUBLOC	ORA	D?8210	DPB	DNI	DCU	DCO	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
1	82	1	FILTER			0.010	.	.	0	1.18	0	3	GREAT BEAR LAKE	.	.	0	0	0	0	.	.	.	.	.	0	.	0	.	.	C	0	.
2	63	1	FILTER	.	.	0.052	0.032	.	.	.	.	.	KO3	.	.	0	0	0	0	.	.	.	.	.	.	.	0	0	.	.	.	.
3	83	1	UNFILTER	.	.	0.074	0.033	.	.	.	.	.	KC3	0	.	0	0	0	0	.	.	.	.	.	.	.	0	0	.	.	.	.
4	83	1	FILTER	0.0023	.	0.042	0.032	.	.	.	.	.	KO4	.	.	0	0	0	0	.	.	.	.	.	.	.	.	0	.	.	.	.
5	83	1	UNFILTER	0.0003	.	0.049	5.033	.	.	.	.	.	KC4	0	.	0	.	0	0	.	.	.	.	.	.	.	.	0	.	.	.	.
6	83	8	FILTER	0.0500	0.00018	0.020	0.010	.	.	.	.	.	GARBAGE LAKE	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7	(33	9	FILTEG	0.0790	.	0.110	0.014	.	.	.	.	.	GARJAGE LAKE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
8	83	10	FILTER	0.0580	.	0.089	0.014	.	.	.	.	.	GARBAGE LAKE	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
9	82	1	FILTER	0.0500	.		.	.	5	1.39	0	0	GARBAGE LAKE	.	.	0	.	0	0	.	.	.	.	.	0	.	.	.	0	0	0	.

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAREA	AMEN3	SAMPTYPE	SAMPIO	RNUM	PH	CONDO	MOIST	LUI	CRA	ERA	CPB210	EPB210	CPA	CNI	CCU	CCO	CCO2	ECO2	CA2CODE	CU
10	R	01	N	.	.	.	NC AMENDMENT	WATER	SURFACE YATER	.	8.1	340	.	.	.	.	.	.		0.0700			.	.	.	.
11	R	01	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	8.1	350	.	.	.	.	.	.		0.0600		.	.	.	.	0.1960
12	R	01	N	.	.	.	NC AMENDMENT	WATER	SURFACE YATER	.	8.2	34c	.	.	.	.	.	.		0.0700		.	.	.	.	0.5440
13	R	01	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	8.2	340	.	.	.	.	.	.	0.0800	0.0500			.	.	.	0.2790
14	R	01	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	8.2	350	.	.	.	.	.	.	.	0.5600			.	.	.	0.1500
15	R	01	N	.	.	.	hC AYENOMENT	WATER	SURFACE YATER	.	8.2	350	.	.	.	.	.	.		0.0800		.	.	.	.	0.3550
16	R	01	N	.	.	.	NJ AMENDMENT	WATER	SURFACE WATER	.	8.2	260	.	.	1.9	.	1.1	.		0.0370	0.5022	3.5520	.	.	2	0.0610
17	R	01	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	6.2	260	.	.	.	.	.	.		0.0034	0.5020	0.3020	.	.	2	.
18	R	01	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	6.2	260	.	.	.	.	.	.	.	0.0034		0.0023	.	.	2	.

OBS	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	BACODE	CTI	ETI	T1CODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE	CNA	ENA	NACODE	CVA	EVA	VACODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE	OATE	SUBAREA
10	.	0	.	.	.	0.13	.	1	.	.	.	.	.	.	.	.	.	.	.	.	14.99	.	I	.	.	.	0.31	.	1	0.35	.	1	0.02	.	1	.	.	.	34.53	.	1	82	2
11	.	1	.	.	.	0.17	.	1	.	.	.	.	.	.	.	.	.	.	.	.	15.11	.	1	.	.	.	0.01	.	1	0.41	.	1	0.01	.	1	.	.	.	34.71	.	1	82	3
12	.	1	.	.	.	0.13	.	1	.	.	.	.	.	.	.	.	.	.	.	.	14.98	.	1	.	.	.	.	.	0	0.22	.	1	.	.	0	.	.	.	34.55	.	1	82	4
13	.	1	.	.	.	0.14	.	1	.	.	.	.	.	.	.	.	.	.	.	.	14.47	.	1	.	.	.	0.01	.	1	1.06	.	1	0.01	.	1	.	.	.	33.34	.	1	82	5
14	.	1	.	.	.	0.14	.	1	.	.	.	.	.	.	.	.	.	.	.	.	14.96	.	1	.	.	.	0.01	.	1	0.15	.	1	0.02	.	1	.	.	.	34.17	.	1	82	6
15	.	1	.	.	.	0.15	.	1	.	.	.	.	.	.	.	.	.	.	.	.	15.31	.	1	.	.	.	0.01	.	1	0.38	.	I	0.01	.	1	.	.	.	35.37	.	1	82	7
16	0.01	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	8
17	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	9
18	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	10

OBS	TEXTURE	CAS	CCD	CFE	CZN	CTH	CCR	CSI	CAG	CAU	SUBLOC	DRA	DPB210	DPB	DNI	DCU	DCO	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
10	FILTEH	0.0500	.	0.020		.	0	1.33	0.00	0	GARBAGE LAKE	.	.	0	.	0	0	0	.	.	.	.	.	.	.	.	.	0	0	.
11	FILTEH	0.0400		0.010		.	0	1.91	0.00	0	GARBAGE LAKE	.	.	0	.	0	0	.	.	.	.	.	.	.	.	.	.	0	0	.
12	F▮LTER	0.0600	.	.		0.07	0	1.75	0.00	a	GARBAGE LAKE	.	.	0	.	0	0	.	.	.	0	.	0	.	.	.	0	0	.	.
13	FILTER	0.0500			0.010	0.03	0	1.79	0.00	0	GARBAGE LAKE	.	.	.	.	0	0	.	.	.	.	.	.	.	.	.	0			
14	FILTER	0.0500			.	.	0	1.36	0.00	0	GARBAGE LAKE	.	.	0	.	0	0	.	.	.	.	.	.	.	.	.	0	d	d	:
15	FILTER	0.0600	.	0.020	0.010	0.02	0	1.42	0.00	0	GARBAGE LAKE	.	.	0	.	0	0	.	.	.	.	.	.	.	.	.	.	.	.	.
16	UNFILTER	0.0820	.	0.072	0.010	.	.	.	.	.	GARBAGE LAKE	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
17	UNFILTER	0.0680	.	0.054	0.011	.	.	.	.	.	GARBAGE LAKE	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
18	UNFILTER	0.1050	.	0.056	0.018	.	.	.	.	.	GARBAGE LAKE	.	.	0	.	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SUHAREA	AMEND	SAHPTYPE	SAMPID	RNUM	PH	CUNDO	MOIST	LOI	CRA	ERA	CPB210	EPB210	CPB	CN1	CCU	CCU	CCU2	ECU2	CO2CODE	CU
19	R	01	N	.	.	.	NO AMENDMENT	WATER	BOTTOM WATER	.	.	.	.	.	.	.	.	.	.	3.0051	0.3012	0.0019	.	.	2	.
20	R	01	N	.	.	.	NG AMENDMENT	WATER	BOTTOM WATER	.	.	.	.	.	.	.	.	.	0.0120	0.0650	0.0023	0.0120	.	.	2	.
21	R	01	N	.	.	.	NO AMENDMENT	WATER	BOTTOM YATER	.	8.2	400	.	.	1.9	.	1.4	.	0.0002	0.0280	0.0012	0.0018	.	.	2	0.0920
22	R	01	N	.	.	.	NO AMENDMENT	WATER	BOTTOM WATER	.	8.2	400	.	.	.	.	.	.	0.0043	0.0750	0.0157	0.0320	.	.	2	.
23	R	02	N	.	.	.	NC AMENDMENT	WATER	SURFPCE WATER	.	.	.	.	.	.	.	.	.	0.0004	.		.	0	.	2	.
24	R	02	N	.	.	.	NO ANENOYENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	0.0041	.	0.0190	0.0014	.	.	2	.
25	R	02	N	.	.	.	NC AMENDMENT	YATER	SURFACE WATER	.	8.4	150	.	.	.	.	.	.	.	0.0300	.		.	.	.	0.2940
26	R	02	N	.	.	.	NU AMENDMENT	WATER	SURFACE WATER	.	6.3	140	.	.	.	.	.	.	.	.	.		.	.	.	0.1810
27	R	02	N	.	.	.	NU AMENDMENT	WATER	SURFACE WATER	.	b3	110	.	.	.	.	.	.	0.0900	.			.	.	.	0.3850

OBS	EU	UCODE	CDY	EDY	OYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	ORCODE	CMG	EMG	MGCODE	CNA	ENA	NACODE	CVA	EVA	VACODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE	DATE	SUBAREA
19	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	8
20	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	10
21	0.1	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	,	2	83	8
22	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	10
23	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	6
24	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	83	7
25	.	1	.	.	.	0.03	.	1	.	.	.	.	.	.	.	.	.	.	.	.	8.02	.	1	.	.	.	0.01	.	1	0.35	.	1	0.01	.	1	.	.	.	17.60	.	1	82	1
26	.	1	.	.	.	0.03	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.76	.	1	.	.	.	.	.	0	0.05	.	1	.	.	0	.	.	.	16.83	.	1	82	2
27	.	1	.	.	.	0.03	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.59	.	1	.	.	.	0.01	.	1	0.86	.	1	.	.	0	.	.	.	16.48	.	1	82	3

OBS	TEXTURE	CAS	CCD	CFE	CZN	CTH	CCR	CSI	CAG	CAU	SUBLUC	DRA	DPa2IO	DPB	DNI	DCU	DCO	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
25	FILTER	0.1200	.	0.030	.	0.03	0	1.51	0.00	0	COBALT CHANNEL	.	.	0	.	0	0	.	.	.	.	.	.	.	.	.	.	0	.	.
26	FILTER			.	.	.	0	1.15	0.00	0	COBALT CHANNEL	.	.	0	0	0	0	.	.	.	0	.	0	.	0	.	0	0	0	.
27	FILTER		.			0.05	0	1.46	0.00	0	COBALT CHANNEL	.	.	.	0	0	0	.	.	.	.	.	0	.	0	.	0	0	.	.

-A28-

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAHEA	AMEND	SAMPTYPE	SAMPIO	RhUM	PH	CONDU	UOIST	LJI	CRA	ERA	CPB210	EPB210	CPI	CNI	CCU	CCC	CCO2	ECO2	CO2CODE
2d	R	02	N	.	.	.	NC AMENDMENT	YATER	SURFACE YATEK	.	32	130	.	.	.	.		.	.				.	.	.
29	R	02	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	7.8	120	.	.	.	.	3.0	.	0.0005				.	.	2
30	R	02	N	.	.	.	NC AMENDMENT	WATER	SURFACE YATEH	.	6.8	130	.	.	.	.	0.5	.	.		0.0350	0.0012	.	.	2
31	R	02	N	.	.	.	NC AMENDMENT	WATER	BOTTOM WATER	.	8.2	180	.	.	.	.		.	0.5900				.	.	.
32	R	03	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.			.	.	.	.	.	.	.		0.0030	0.0013	.	.	2
33	R	03	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATEK	.		.	.	.	.	.	.	.	0.0004	.	.	.	.	.	2
34	R	03	N	.	.	.	NU AMENDMENT	WATER	SUfiFACE WATER	.	e.5	190	.	.	.	.		.	.			.	.	.	.
35	R	03	N	.	.	.	NO AHENDYENT	WATER	SURFACE WATER	.	9.3	130	.	.	.	.		.	0.0600				.	.	.
36	R	03	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	78	120	.	.	.	.	2.7	.	.	.	0:0033	0.0012	.	.	2

OBS	CU	EU	UCODE	CDY	EDY	DYCODE	CBA	EDA	EACCOE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICGCE	CER	EBR	BRCODE	CWG	EMG	MGCODE	CNA	ENA	NACODE	CVA	EV4	V4CODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CC4	ECA	C4CODE
28	.	.	0	.	.	.	0.04	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.59	.	1	.	.	.	0.01	.	1	0.09	.	1	.	.	0	.	.	.	16.27	.	1
29	0.0006	0	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2		.	2
30	0.0041	0	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2		.	2
31	.	.	0	.	.	.	0.06	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.89	.	1	.	.	.	0.01	.	1	0.93	.	1	0.19	.	1	.	.	.	16.72	.	1
32	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2		.	2
33	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2		.	2
34	.	.	0	.	.	.	0.13	.	1	.	.	.	.	.	.	.	.	.	.	.	.	10.83	.	1	.	.	.	0.01	.	1	0.10	.	1	.	.	0	.	.	.	27.59	.	1
35	0.1730	.	1	.	.	.	0.04	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.78	.	1	.	.	.	0.01	.	1	1.10	.	1	.	.	3	.	.	.	17.38	.	1
36	0.0008	0	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2

OBS	DATE	SUBAREA	TEXTURE	CAS	CCD	CFE	CZN	CTH	CCR	CSI	CAG	CAU	SUBLOC	DRA	DB210	DPB	DNI	DCU	DCO	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
28	82	5	FILTER		.		.	.	0	1.12	0.30	0	COBALT CHANNEL	.	.	0	0	0	0	0	.	.	.	.	0	.	0	.	0	0	0	.
29	83	6	UNFILTER		.	0.064	0.037	.	.	.	.	.	COBALT CHANNEL	0	.	.	0	0	0	.	.	.	.	.	.	.	0	0	.	.	.	.
30	83	7	UNFILTER	0.0076	.			.	.		.	.	COBALT CHANNEL	0	.	0	0	.	.	.	.	.	.	.	.	.	.	0	0	0	.	.
31	82	4	FILTER	.	.	0.390	0.030	.	0	1.71	0.00	0	CGBALT CHANNEL	.	.	.	0	0	0	0	.	.	.	.	.	.	0	.	.	.	Q	.
32	83	3	FILLTER	0.0032	.	0.324	0.046	.	.		.	.	BEAR BAY	.	.	0	0	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
33	e3	4	FILTER	-	.	0.048	0.038	.	.		.	.	BEAR BAY	.	.	.	0	0	0	.	.	.	.	.	.	.	0	0	.	.	.	.
34	82	1	FILTER	0.3200	.	.		.	0	1.97	0.00	0	BEAR BAY	.	.	0	0	0	0	0	.	.	.	.	0	.	.	.	0	0	0	.
35	82	2	FILTER	.	.	0.010	0.010	.	0	1.59	0.35	0	BEAR BAY	.	.	.	0	0	0	.	.	.	.	.	0	.	0	.	.	.	0	.
36	83	3	UNF ILTER	0.0037	.	0.024		.	.	.	.	.	BEAR 04Y	3	.	0	0	0	.	.	.	.	.	.	.	.	.	0	.	0	.	.

-A29-

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAREA	AMEND	SAMPTYPE	SAMPID	RNUM	PH	CONDO	HOIST	LUI	CRA	ERA	CPB210	EPB210	CPB	CNI	CCU	CCO	CCO2	ECO2	CO2CODE
37	R	C3	N	.	.	.	NC AYENDMENT	'HATER	SURFACE WATER	.	7.8	120	.	.	.	.	.	.	C.0004	.			.	.	2
38	R	04	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.		.	.	.	.	.	.	.		0.001s	0.0020	.	.	2
39	R	C4	N	.	.	.	NC AHENDMENT	WATER	SURFACE WATER	.	7.2	110	.	.	.	.	.	.	.	0.0200			.	.	.
40	R	C4	N	.	.	.	NC AMENDMENT	WATER	SURF4CE WATER	.	7.0	12u	.	.	.	.	.	.	.	.	.	.	.	.	.
41	R	04	N	.	.	.	NC AMENDMENT	WATER	SUHFACE WATER	.	.		.	.	.	.	6.8	.	.	0.0012	.	0.0020	.	.	2
42	W	05	N	.	.	.	NO AMENDMENT	WATER	SUHFACE WATER	.	.	.	.	.	.	.	.	.	.	0.0273	0.0038	0.0130	.	.	2
43	W	C5	N	.	.	.	NO 4MENDMENT	WATER	SURFACE WATER	.	.		.	.	.	.	.	.	.	3.5024		0.0028	.	.	2
44	R	05	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	0.0025	.	0.0043	.	.	2
45	R	05	N	.	.	.	NO AMENDMENT	WATER	SUKFACE WATER	o	.		.	.	.	.	.	.	.		.	0.0031	.	.	2

OBS	CU	EU	UCODE	CDY	EDY	OYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	ORCODE	CMG	EMG	MGCODE	CNA	ENA	NACODE	CVA	EVA	VACODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE
37	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2		.	2
38	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
39	0.2640	.	1	.	.	.	0.08	.	1	.	.	.	.	.	.	.	.	.	.	.	.	8.06	.	1	.	.	.	0.01	.	1	0.14	.	1	.	.	0	.	.	.	23.01	.	1
40	.	.	0	.	.	.	0.03	.	[illegible]	.	.	.	.	.	.	.	.	.	.	.	.	7.21	.	1	.	.	.	0.01	.	1	0.07	.	2	.	.	0	.	.	2	22.50	.	1
41	0.0037	0	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.									.	.	2
42	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
43	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
44	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
45	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	.	0.02	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2

OBS	DATE	SLEAREA	TEXTURE	CAS	CCC	CFE	CZN	CTH	CCR	CSI	CAG	CAU	SUBLOC	DRA	DPB21C	DPB	DNI	DCU	DCG	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
37	83	4	UNFILTER	.	.	0.086	0.038	.	.	.	.	.	BEAR BAY	.	4	.	0	0	0	.	.	.	.	.	.	.	0	0	.	.	.	.
38	83	2	FILTER	0.0029	.	.	0.018	.	.	.	.	.	BEAR CREEK	.	.	0	0	.	.	.	.	.	.	.	.	.	.	0	0	.	.	.
39	82	1	FILTER	0.0800	.	0.020	.	0.02	0	1.15	0.00	0	BEAR CREEK	.	.	0	.	0	0	.	.	.	.	.	0	.	.	.	.	0	.	.
40	€2	2	FILTER	.	.	.	0.010	.	0	0.79	0.00	5	BEAR CHEEK	.	.	0	0	0	0	3	,	.	.	.	0	.	0	.	0	.	0	.
41	83	2	UNFILTER	0.0034	.	.	0.019	.	.	.	.	.	BEAR CREEK	0	4	0	.	0	.	.	.	.	.	.	.	.	.	0	0	.	.	.
42	e3	E	FILTER	0.0077	.	0.145	0.045	.	.	.	.	.	LABINE BAY	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
43	83	9	FILTER	0.0030	.	0.045	0.032	.	.	.	.	.	LABINE BAY	.	.	0	.	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.
44	83	10	FILTER	0.0067	.	0.033	0.017	.	.	.	.	.	LABINE BAY	.	.	0	.	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.
45	83	11	FILTER	0.0040	.	0.064	0.028	.	.	.	.	.	LABINE BAY	.	.	0	0	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.

WO
I

OBS	SITE	AREA	LOCALE	AGE	TAILWET	SUBAREA	AMEND	SAMPTYPE	SAMPID	RNUM	PH	CGNDO	MOIST	LOI	CRA	EHA	CPB210	EPB210	C?D	CNI	CCU	CCO	CCO2	ECO2	CC2CODE
46	R	05	N	.	.	.	NC AMENDMENT	WATER	SUHFACE WATER	.	.	.	.	.	.	.	.	.	.			0.0018	.	.	2
47	R	05	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	0.0016	0.0110	0.0015	5.0130	.	.	2
.	.	.	.	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	.	0.3311	.	.	.	2
.	.	.	.	.	.	.	NY AMENDMENT	WATER	SURFACE WATER	.	8.4	120	.	.	.	.	.	.	.		.	.	.	.	.
50	R	05	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	7.5	100	.	.	.	.	.	.	.			0.0200	.	.	.
51	R	05	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	7.5	100	.	.	.	.	.	.	.			0.0200	.	.	.
52	R	05	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	7.5	100	.	.	.	.	.	.	.	.	.	0.0100	.	.	.
53	R	05	N	.	.	.	NC ACENDHENT	WATER	SURFACE YATER	.	8.3	145	.	.	.	.	.	.	.			.	.	.	.
54	R	05	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	6.0	145	.	.	.	.	.	.	.	.		.	.	.	.

OBS	CU	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE	CNA	ENA	NACODE	CVA	EVA	VACODE	C4L	EAL	ALCUDE	CMh	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE
46	.	.	2	.	0	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2		.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2		.	2
47	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
48	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
49	.	.	0	.	o	.	0.04	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.58	.	1	.	.	.	0.01	.	1	0.12	.	1	.	.	0	.	.	.	16.16	.	1
50	0.2030	.	1	.	.	.	0.06	.	1	.	.	.	.	.	.	.	.	.	.	.	.	8.19	.	1	.	.	.	0.01	.	1	0.14	.	1	.	.	0	.	.	.	17.86	.	1
51	0.2790	.	1	.	.	.	0.04	.	I	.	.	.	.	.	.	.	.					7.35	.	1	.	.	.	0.01	.	1	0.13	.	1	.	.	0	.	.	.	15.75	.	1
52	.	.	0	.	.	.	0.05	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.64	.	1	.	.	.	0.01	.	1	0.07	.	1	.	.	0	.	.	.	16.45	.	1
53	0.2410	.	1	.	.	.	0.03	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.67	.	1	.	.	.	0.01	.	1	0.16	.	1	.	.	0	.	.	.	16.43	.	1
54	0.1200	o	1	.	.	.	0.04	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7.65	.	1	.	.	.	0.01	.	1	0.09	.	1	.	.	0	.	.	.	16.51	.	1

OBS	DATE	SUBAREA	TEXTURE	CAS	CCD	CFE	CZN	CTI	CCH	CS	CAG	CAU	SUBLOC	DRA	DPB210	DPB	DNI	DCU	DCO	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
46	83	12	FILTER			0.032	0.028	.	.	.	.	.	LABINE BAY	.	.	0	0	0	.	.	.	.	.	.	.	.	0	0	.	.	.	.
47	83	13	FILTER	0.0370	.	0.360	0.036	.	.	.	.	.	LABINE BAY	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
48	83	14	FILTER		o	0.029	0.035	.	.	.	.	.	LABINE BAY	.	.	0	0	.	0	.	.	.	.	.	.	.	0	0	.	.	.	.
49	82	1	FILTER		o	.	.	.	0	1.10	0.00	0	LABINE BAY	.	.	0	0	0	J	0	.	.	.	.	0	.	0	.	0	0	0	.
50	d2	2	FILTER	0.2400	.	0.013	.	.	0	2.25	0.00	0	LABINE BAY	.	.	0	0	0	.	.	.	.	.	.	0	.	.	.	.	0	0	.
51	92	3	FILTER	0.0600	.		.	0.02	0	1.11	0.00	0	LABINE BAY	.	.	0	0	0	.	.	.	.	.	.	0	.	.	.	0	0	.	.
52	02	4	FILTER	0.0500	.	.		.	0	1.35	0.18	0	LABINE BAY	.	.	0	0	5	.	0	.	.	.	.	0	.	.	.	0	0	0	.
53	82	5	FILTER		.	.		.	0	1.07	0.00	0	LABINE BAY	.	.	0	0	0	0	.	.	.	.	.	0	.	0	.	0	0	0	.
54	82	6	FILTER	.	.		.	.	0	1.12	0.00	0	LABINE DAY	.	.	0	0	0	0	.	.	.	.	.	0	.	0	.	0	0	0	.

OBS	SITE	AREA4	LOCALE	AGE	TAIL*T	SURAREA	AMEND	SAMPTYPE	SAMPID	RNUM	PH	CONDU	MOIST	LOI	CRA	ERA	CPB210	EPB210	CPB	CNI	CCU	CCO	CCO2	ECO2	CO2CODt
55	.	55	.	.	.	.	NC AMENDMENT	WATER	SLRFACE WATER	.	7.4	160	.	.	.	.	0.5	.	.		.	.	.	.	2
56	R	05	h	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	7.9	140	.	.	.	.	5.5	.	.	0.0023	.	0.0027	.	.	2
57	R	55	N	.	.	.	NC AMENDMENT	WATER	SLRFACE WATER	.	.	.	.	.	.	.	.	.	.	0.5030	.	0.0028	.	.	2
58	h	05	.	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	74	105	.	.	.	.	2.2	.	.		.	0.0019	.	.	2
59	R	05	N	.	.	.	NU AMENDMENT	WATER	SLRFACE WATER	.	7.6	125	.	.	.	.	10.8	.	.	.		0.0017	.	.	2
60	R	05	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	7.6	100	.	.	30	.	9.5	.	0.0003	0.0084	0.0016	0.0120	.	.	2
61	R	05	N	.	.	.	NC AMENDMENT	WATER	SURFACE WATER	.	7.8	120	.	.	.	.	1.4	.	0.0004	.	0.0014	.	.	.	2
62	R	06	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	8.2	130	.	.	.	.	.	.	.	.	.	.	.	.	.
63	R	08	.	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	7.5	3600	.	.	10.8	.	3.8	.	0.0015	0.2100	0.2100	7.2000	.	.	2

OBS	CU	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	a4CODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE	CNA	ENA	N4CODE	CVA	EVA	VACODE	CAL	EAL	ALCODE	CMN	EHN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE
55	0.0013	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
56	0.0084	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
57	.		2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
58	0.0032	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
59	0.0019	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
60	0.0150	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
61	0.0016	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
62	.	.	0	.	.	.	0.03	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	0.01	.	1	0.06	.	1	.	.	0	.	.	.	16.41	.	1
63	4.2000	0.21	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2

OBS	DATE	SUBAREA	TEXTURE	CAS	CCD	CFE	CZN	CTH	CCR	CSI	CAG	CAU	SUBLOC
55	83	b	UNFILTER	0.0028		0.070	0.026	.	.	.	.	.	LABINE BAY
56	83	Y	UNFILTER	0.0030		0.056	0.032	.	.	.	.	.	LABINE BAY
57	83	10	UNFILTER	0.0030		0.046	0.017	.	.	.	.	.	LABINE BAY
58	83	11	UNFILTER	0.0042		0.066	0.028	.	.	.	.	.	LABINE BAY
59	83	12	UNFILTER		.	0.040	0.021	.	.	.	.	.	LABINE JAY
60	83	13	UNFILTER	0.0400		0.071	0.037	.	.	.	.	.	LABINE BAY
61	83	14	UNFILTER		.	0.042	0.030	.	.	.	.	.	LABINE BAY
52	82	1	FILTER	.	.			.	0	1.14	0	5	MURPHY BAY
63	83	1	FILTER	4.2000	0.00100	0.330	2.400	.	.	.	.	.	SILVER POINT

OBS	DRA	DPB210	DPB	DNI	DCU	DCO	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
55	0	.	0	0	0	0	.	.	.	.	.	.	.	.	0	.	.	.	.
56	0	.	0	.	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.
57	.	.	0	.	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.
58	0	.	0	0	0	.	.	.	.	.	.	.	.	.	0	.	.	.	.
59	0	.	0	0	0	.	.	.	.	.	.	.	.	0	0	.	.	.	.
60	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
61	0	.	.	0	.	0	.	.	.	.	.	.	.	0	0	.	.	.	.
52	.	.	0	0	0	0	0	.	0	.	.	0	.	0	.	0	0	0	.
63	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

OBS	SITE	AREA4	LOCALE	AGE	TAILWT	SURAREA	AMEND	SAMPTYPE	SAMPID	RNUM	PH	COND	MOIST	LOI	CRA	ER4	CPB210	EPB210	CPB	CNI	CCU	CCO
64	R	08	N	.	.	.	NO AMENDMENT	WATER	SUHFACE WATER	.	7.5	3600	.	.	81.1	.	51.4	.	0.0018	0.2500	0.1900	6.2000
65	R	09	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	0.3490	0.0700	0.7300
66	R	04	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.			0.0042
67	R	OF	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	7.0	750	.	.	10.8	.	51.4	.	.	0.1000	0.0770	0.7400
68	R	09	h	.	.	.	AC AMENDMENT	WATER	SLRFACE WATER	.	7.4	120	.	.	.	.	81.1	.	.		.	0.0042
69	R	13	N	.	.	.	NO AMENDMENT	WATER	SURFACE WATER	.	.	.	.	.	.	.	.	.	.	0.5072	0.0022	0.0012
70	R	13	N	.	.	.	NO AMENCYENT	WATER	SUAFACE WATER	.	.	.	.	.	3.0	.	1.1	.	0.0015	0.0360	0.5060	0.0060

OBS	CCU2	ECU2	CC2CCCE	CU	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE	CNA	ENA	NACODE	CVA	EVA	VACODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE
t4	.	.	2	5.8000	0.29	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
65	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
66	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	.	0.02	.	2	.	.	2	.	.	2
67	.	.	2	0.3510	0.04	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
68	.	.	2	0.0014	0.30	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
€9	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2
70	.	.	2	0.0065	0.00	1	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2

OBS	DATE	SUBAREA	TEXTURE	CAS	CCD	CFE	CZN	CTH	CCR	CSI	CAG	CAU	SUBLJC	DRA	DPB210	DPB	DNI	DCU	DCU	DU	DBA	DMG	DVA	DAL	DMN	DCA	DAS	DCD	DFE	DZN	DTH	DSI
64	03	1	UNFILTER	4.3000	0.0012C	0.350	1.400	.	.	.	.	.	SILVER POINT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
65	83	1	FILTER	7.0000	0.00130	0.035	0.240	.	.	.	.	.	WEST AUDIT	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
66	83	2	FILTER	0.0018	C.00015	0.053	.	.	.	.	.	.	WEST AUDIT	.	.	0	0	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.
b?	83	1	UNFILTER	7.7000	0.00260	0.107	0.240	.	.	.	.	.	WEST AUDIT	.	.	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
68	83	2	UNFILTER	0.0325	0.00010	0.053	.	.	.	.	.	.	WEST AUDIT	0	.	0	0	3	.	.	.	.	.	.	.	.	.	.	.	0	.	.
69	83	2	FILTER	0.011C	.	0.079	0.011	.	.	.	.	.	GARBAGE CREEK	.	.	0	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.
70	83	2	UNFILTER	0.0160	.	0.476	0.016	.	.	.	.	.	GAKBAGE CREEK	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	.	.	.	.

Page

Section A3 Data Summaries of Port Radium Tailings

PORT RADIUM DATA DUMPO F 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	PH MEAN	PH STD	PH N	CONDO MEAN	CONDO STD	CONDO N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	3.10	.	1.00	1200.00	.	1.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	8.00	0.00	2.00	180.00	0.00	2.00
			MIXED	8.40	0.00	2.00	170.00	0.00	2.00
			ORGANIC	8.00	.	1.00	140.00	.	1.00
			SOIL	8.00	.	1.00	140.00	.	1.00
			GRAB	.	.	0.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	8.60	.	1.00	150.00	.	1.00
			CLAY	8.60	.	1.00	150.00	.	1.00
			GRAB	7.70	0.23	4.00	82.50	18.93	4.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	0.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	7.10	0.28	2.00	955.00	205.06	2.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	7.60	.	1.00	80.00	.	1.00
			GITZ	7.40	0.00	2.00	220.00	0.00	2.00
			CLAY	7.50	.	1.00	80.00	.	1.00
			GRAB	7.43	0.40	3.00	140.00	17.32	3.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	7.95	0.78	2.00	160.00	28.28	2.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	7.40	.	1.00	850.00	.	1.00
			FINES	7.40	.	1.00	300.00	.	1.00
		20-25 CM DEEP	COARSE	7.30	0.14	2.00	265.00	35.36	2.00
			FINES	7.20	.	1.00	600.00	.	1.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7.

				PH			CONDO		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	4.30	.	1.00	1700.00	.	1.00
			GRAB	3.67	1.14	7.00	5157.14	3578.5+	7.00
		20-25 CM DEEP	COARSE	7.60	*	1.00	260.00	.	1.00
			FINES	6.70	.	1.00	640.00	*	1.00
			ORGANIC	5.50	.	1.00	2000.00	.	1.00
		UNKNOWN	COARSE	5.20	.	1.00	500.00	.	1.00
			FINES	6.30	.	1.00	430.00	.	1.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	6.90	.	1.00	560.00	.	1.00
			FINES	7.55	0.07	5.00	420.00	113.14	2.00
			GRAB	7.57	1.01	3.00	4903.33	7880.36	3.00
		20-25 CM DEEP	COARSE	5.40	2.25	3.00	1050.00	708.87	3.00
			FINES	7.33	0.40	3.00	486.67	237.14	3.00
			ORGANIC	7.30	.	1.00	270.00	.	1.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	7.70	.	1.00	170.00	.	1.00
			MIXED	7.37	0.26	4.00	182.50	38.62	4.00
PARKING LOT	OVERBURDEN	SURFACE	CCARSE	8.00	.	1.00	500.00	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	7.20	.	1.00	480.00	.	1.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	7.90	.	1.00	230.00	.	1.00

SUBLOC	SAMPTYPE	SAMFID	TEXTURE	MOIST MEAN	MOIST STD	MOIST N	LOI MEAN	LOI STD	LOI N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	1.20	.	1.00	11.60	.	1.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	4.75	2.19	2.00
			MIXED	.	.	0.00	2.35	0.92	2.00
			ORGANIC	.	.	0.00	12.70	.	1.00
			SOIL	.	.	0.00	3.90	.	1.00
			GRAB	.	.	0.00	2.70	2.26	2.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	3.00	.	1.00
			CLAY	.	.	0.00	1.90	.	1.00
			GRAB	.	.	0.00	3.50	2.28	4.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	0.00	0.30	.	1.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	0.80	0.42	2.00	8.10	.	1.00
LADINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	1.70	.	1.00
			GITZ	.	.	0.00	10.55	0.07	2.00
			CLAY	.	.	0.00	0.80	.	1.00
			GRAB	.	.	0.00	2.77	1.00	3.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	.	.	0.00	0.35	0.07	2.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	0.10	.	1.00	1.10	.	1.00
			FINES	0.20	.	1.00	1.50	.	1.00
		20-25 CM DEEP	COARSE	0.15	0.07	2.00	2.00	0.42	2.00
			FINES	0.10	.	1.00	1.00	.	1.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	MOIST MEAN	MOIST STD	MOIST N	LOI MEAN	LOI STD	LOI N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	1.00	.	1.00	5.50	.	1.00
			GRAB	2.17	4.04	7.00	4.91	5.53	7.00
		20-25 CM DEEP	COARSE	0.10	.	1.00	2.90	.	1.00
			FINES	0.80	.	1.00	3.40	.	1.00
			ORGANIC	2.40	.	1.00	17.30	.	1.00
		UNKNOWN	COARSE	0.90	.	1.00	10.40	.	1.00
			FINES	1.60	.	1.00	2.80	.	1.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	0.10	.	1.00	3.40	.	1.00
			FINES	0.60	0.28	2.00	2.55	1.34	2.00
			GRAB	1.93	2.24	3.00	3.57	2.66	3.00
		20-25 CM DEEP	COARSE	1.47	2.20	3.00	5.33	5.60	3.00
			FINES	1.47	2.19	3.00	3.33	0.85	3.00
			ORGANIC	1.50	.	1.00	46.60	.	1.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	0.20	.	1.00	0.50	.	1.00
			MIXED	0.17	0.10	4.00	1.05	0.60	4.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	0.20	.	1.00	2.00	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	.	.	0.00	4.90	.	1.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	0.60	.	1.00	2.10	.	1.00

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CRA MEAN	CRA STD	CRA N	DRA MEAN	DRA STD	DRA N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	0.00	.	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	7.33	.	1.00	.	.	0.00
			MIXED	.	.	0.00	.	.	0.00
			ORGANIC	27.47	.	1.00	.	.	0.00
			SOIL	1.42	.	1.00	.	.	0.00
			GRAB	38.75	24.47	2.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	34.59	.	1.00	.	.	0.00
			CLAY	.	.	0.00	.	.	0.00
			GRAB	9.44	5.13	2.00	.	.	0.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	0.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	29.92	8.31	2.00	.	.	0.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	201.40	.	1.00	.	.	0.00
			GITZ	8.54	12.08	2.00	.	.	0.00
			CLAY	25.23	.	1.00	.	.	0.00
			GRAB	325.20	.	1.00	.	.	0.00
Silver Point	Bare Tailings	SURFACE	GRAB	67.58	.	1.00	.	.	0.00
			COARSE	.	.	0.00	.	.	0.00
			FINES	17.32	.	1.00	.	.	0.00
		20-25 CM DEEP	COARSE	20.93	2.84	2.00	.	.	0.00
			FINES	3.45	.	1.00	.	.	0.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLUC	SAMPTYPE	SAMPID	TEXTURE	CRA MEAN	CRA STD	CRA N	DRA MEAN	DRA STD	DRA N
WEST A DIT	BARE TAILINGS	SURFACE	COARSE	665.49	210.59	4.00	.	.	0.00
			GRAB	211.67	129.31	6.00	.	.	0.00
		20-25 CM DEEP	COARSE	810.90	.	1.00	.	.	0.00
			FINES	722.40	316.22	2.00	.	.	0.00
			ORGANIC	311.96	93.99	2.00	.	.	0.00
		UNKNOWN	COARSE	520.50	.	1.00	.	.	0.00
			FINES	265.80	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	.	.	0.00
			FINES	8.10	.	1.00	.	.	0.00
			GRAB	27.08	22.56	2.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	3.00	.	.	0.00
			FINES	12.81	.	1.00	.		0.00
			ORGANIC	.	.	0.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	74.95	58.04	0.00	.	.	0.00
			MIXED	88.95	17.18	2.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GRAB	.	.	0.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	23.97	.	1.00	.	.	0.00

				CPB210			DPB210		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	0.00		.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	4.82	.	1.00		.	0.00
			MIXED	.	.	0.00	.	.	0.00
			ORGANIC	6.04	.	1.00	.	.	0.00
			SOIL	5.83	.	1.00	.	.	0.00
			GRAB	15.50	12.49	2.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	6.52	.	1.00	.	.	0.00
			CLAY	.	.	0.00	.	.	0.00
			GRAB	8.90	1.78	2.00	.	.	0.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	0.00	.	.	0.00
OEAR CREEK	BARE TAILINGS	SURFACE	GRAB	15.37	5.95	2.00	.	.	0.00
LARINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	11.78	.	1.00	.	.	0.00
			GITZ	22.78	22.51	2.00	.	.	0.00
			CLAY	8.55	.	1.00	.	.	0.00
			GRAB	93.51	.	1.00	.	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	GRAB	24.06	.	1.00	.	.	0.00
			COARSE	.	.	0.00	.	.	0.00
			FINES	3.83	.	1.00	.	.	0.00
		20-25 CM DEEP	COARSE	3.52	1.91	2.00	.	.	0.00
			FINES	3.37	.	1.00	.	.	0.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA   12:03 WEDNESDAY, MARCH 7,

				CPB210			DPB210		
				MEAN	STD	N	MEAN	STD	N
SUBLUC	SAMPTYPE	SAMPID	TEXTURE						
WEST A DIT	BARE TAILINGS	SURFACE	COARSE	435.80	362.74	4.00	.	.	0.00
			GRAB	124.48	90.67	6.00	.	.	0.00
		20-25 CM DEEP	COARSE	675.75	.	1.00	.	.	0.00
			FINES	509.67	617.13	2.00	.	.	0.00
			ORGANIC	178.18	206.73	2.00	.	.	0.00
		UNKNOWN	COARSE	59.20	.	1.00	.	.	0.00
			FINES	34.40	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	.	.	0.00
			FINES	6.18	.	1.00	.	.	0.00
			GRAB	10.46	4.53	2.00	.	.	0.00
		20-25 CM DEEP	COARSE	17.32	13.96	3.00	.	.	0.00
			FINES	10.74	.	1.00			0.00
			ORGANIC	.	.	0.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	.	.	0.00
			MIXED	33.03	29.55	2.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GRAB	.	.	0.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	7.06	.	1.00	.	.	0.00

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CSR MEAN	CSR STD	CSR N	DSR MEAN	DSR STD	DSR N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	0.00	698.02	.	1.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	20986.46	164.02	2.00
			MIXED	.	.	0.00	6504.19	.	1.00
			ORGANIC	.	.	0.00	4427.55	.	1.00
			SOIL	.	.	0.00	934.64	.	1.00
			GRAB	.	.	0.00	6396.13	99.21	2.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	7294.17	.	1.00
			CLAY	.	.	0.00	17211.42	.	1.00
			GRAB	.	.	0.00	8995.28	4346.86	4.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	0.00	776.61	.	1.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	4882.32	2027.51	2.00
LARINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	5085.84	.	1.00
			GITZ	.	.	0.00	755.10	25.02	2.00
			CLAY	.	.	0.00	974.32	.	1.00
			GRAB	.	.	0.00	3247.50	3693.36	3.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	.	.	0.00	946.75	72.42	2.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	7079.94	.	1.00
			FINES	.	.	0.00	6647.08	.	1.00
		20-25 CM DEEP	COARSE	.	.	0.00	12588.44	6913.00	2.00
			FINES	.	.	0.00	5797.32	.	1.00

(CONTINUED)

				CSR			OSR		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	2512.76	.	1.00
			GRAB	.	.	0.00	908.56	324.96	6.00
		20-25 CM DEEP	COARSE	.	.	0.00	17633.30	.	1.00
			FINES	.	.	0.00	3851.55	.	1.00
			ORGANIC	.	.	0.00	2170.48	.	1.00
		UNKNOWN	COARSE	*	.	0.00	1147.33	.	1.00
			FINES	*	*	0.00	2819.10	.	1.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	*	0.00	21447.43	.	1.00
			FINES	.	.	0.00	9860.86	13004.01	2.00
			GRAB	.	*	0.00	11883.25	9663.36	3.00
		20-25 CM DEEP	COARSE	.	.	0.00	6355.98	9902.19	3.00
			FINES	.	*	0.00	11806.10	8400.30	3.00
			ORGANIC	.	*	0.00	1199.00	.	1.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	1173.46	.	1.00
			MIXED	.	.	0.00	2393.46	816.77	4.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	5146.64	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	.	.	0.00	1176.61	.	1.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	3820.37	.	1.00

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CU MEAN	CU STD	CU N	DU MEAN	DU STD	DU N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	2.69	.	1.00	.	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	110.07	3.88	2.00	.	*	0.00
			MIXED	103.69	.	1.00	.	.	0.00
			ORGANIC	638.08	@	1.00	.	*	0.00
			SOIL	47.[illegible]	@	1.00	.	.	0.00
			GRAB	95.94	62.89	3.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	154.41	.	1.00	.	.	0.00
			CLAY	110.79	.	1.00	.	.	0.00
			GRAB	129.20	41.39	4.00	.	.	0.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	9.58	.	1.00	@	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	46.05	27.94	2.00	@	.	0.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	333.83	.	1.00	.	.	0.00
			GITZ	41.00	9.58	2.00	@	@	0.00
			CLAY	51.67	.	1.00	@	*	0.00
			GRAB	366.01	343.52	3.00	*	@	0.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	321.42	22.73	2.00	@	@	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	67.10	@	1.00	.	.	0.00
			FINES	24.55	@	1.00	*	*	0.00
		20-25 CM DEEP	COARSE	65.35	8.51	3.00	.	.	0.00
			FINES	121.78	.	1.00	.	.	0.00
		SURFACE	GRAB	157.00	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7.

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CU MEAN	CU STD	CU N	DU MEAN	DU STD	DU N
WEST ADIT	BARE TAILINGS	SURFACE	COARSE	742.88	354.50	4.0	.	.	0.00
			GRAB	771.52	947.47	7.00	.	.	0.00
		20-25 CM DEEP	COARSE	906.32	1122.43	2.?	.	.	0.00
			FINES	1901.62	125.00	2.0	.	.	0.00
			ORGANIC	1812.42	1368.37	2.0	.	.	0.00
		UNKNOWN	COARSE	1023.27	.	1.00	.	.	0.00
			FINES	1364.60	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	72.28	.	1.00
			FINES	142.78	19.18	2.00	.	.	0.00
			GRAB	97.45	36.75	3.00	.	.	0.00
		20-25 CM DEEP	COARSE	78.17	11.06	3.00	.	.	0.00
			FINES	85.48	19.1	2.00	78.20	.	1.00
			ORGANIC	1195.52	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	1476.61	.	1.00	.	.	0.00
			MIXED	1198.36	198.69	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	82.06	.	1.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GRAB	69.65	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	21.47	.	1.00	.	.	0.00

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CCO2 MEAN	CCO2 STD	CCO2 N	DCO2 MEAN	DCO2 STD	DCO2 N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	0.00	13.43	.	1.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	290.48	42.25	2.00
			MIXED	160.04	.	1.00	.	.	0.00
			ORGANIC	10.91	.	1.00	.	.	0.00
			SOIL	36.29	.	1.00	.	.	0.00
			GRAB	76.72	.	1.00	54.78	.	1.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	75.95	.	1.00
			CLAY	.	.	0.	296.61	.	1.00
			GRAB	158.75	13.7+	3.00	242.10	.	1.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	36.68	.	1.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	167.91	.	.00	39.10	.	1.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	179.C0	.	1.00	.	.	0.00
			GITZ	47.97	14.82	2.00	.	.	0.00
			CLAY	41.77	.	1.00	.	.	0.00
			GRAB	143.84	113.IV	2.00	82.59	.	1.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	1435.0d	905.97	2.00	.	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	128.81	.	1.00	.	.	0.00
			FINES	2150.88	.	1.00	.	.	0.00
		20-25 CM DEEP	COARSE	166.14	.	1.00	282.98	.	1.00
			FINES	70.89	.	1.00	.	.	0.00

(CONTINUED)

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CC02 MEAN	CC02 STD	CC02 N	DC02 MEAN	DC02 STD	DC02 N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	40.86	.	1.00
			GRAB	172.01	221.97	6.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	0.00	276.07	.	1.00
			FINES	476.52	.	1.00	.	.	0.00
			ORGANIC	.	.	0.00	41.79	.	1.00
		UNKNOWN	COARSE	42.97	.	1.00	.	.	0.00
			FINES	247.48	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	311.98	.	1.00	.	.	0.00
			FINES	167.30	130.57	2.00	.	.	0.00
			GRAB	11.80	.	1.00	278.83	28.48	2.00
		20-25 CM DEEP	COARSE	19.86	7.30	2.00	274.57	.	1.00
			FINES	465.73	397.72	3.00	.	.	0.00
			ORGANIC	819.57	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	1097.39	.	1.00	.	.	0.00
			MIXED	1134.63	603.55	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	55.50	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	149.38	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	41.97	.	1.00

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	SOL MEAN	SOL STD	SOL N	OPL MEAN	OPL STD	OPL N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	47194.54	.	1.00	.	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	45682.44	.	1.00	38560.46	.	1.00
			MIXED	41849.16	.	1.00	.	.	0.00
			ORGANIC	51110.30	.	1.00	.	.	0.00
			SOIL	66233.78	.	1.00	.	.	0.00
			GRAB	34601.32	9398.33	2.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	39237.80	.	1.00	.	.	0.00
			CLAY	.	.	0.00	39072.69	.	1.00
			GRAB	43042.58	5&15.67	[illegible]	.	.	0.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GAAB	60300.19	.	0.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	44082.17	13869.93	2.00	.	.	0.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	52770.60	.	1.00	.	.	0.00
			GITZ	62234.89	2430.18	2.00	.	.	0.00
			CLAY	67954.61	.	1.00	.	.	0.00
			GRAB	47044.29	6086.00	3.00	.	.	0.00
MURPH-BAH	SEDIMENT	SURFACE	GRAB	42783.13	2927.32	2.00	.	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	30160.09	.	1.00	.	.	0.00
			FINES	.	.	0.00	22825.87	.	1.00
		20-25 CM DEEP	COARSE	51742.94	1009.54	2.00	.	.	0.00
			FINES	47463.31	.	1.00	.	.	0.00

(CONTINUED)

				CAL			DAL		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	60212.72	.	1.00	.	.	0.00
			GRAB	47236.64	13944.97	7.00	.	.	0.00
		20-25 CM DEEP	COARSE	42557.01	.	1.00	.	.	0.00
			FINES	65014.80	.	1.00	.	.	0.00
			ORGANIC	.	.	0.00	3120.66	.	1.00
		UNKNOWN	COARSE	61831.30	.	1.00	.	.	0.00
			FINES	73364.06	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	33462.94	.	1.00
			FINES	41639.59	11977.81	2.00	.	.	0.00
			GRAB	37044.49	5615.54	3.00	.	.	0.00
		20-25 CM DEEP	COARSE	38897.65	8019.50	3.00	.	.	0.00
			FINES	30353.66	792.86	2.00	103732.62	.	1.00
			ORGANIC	23104.64	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	41044.12	.	1.00	.	.	0.00
			MIXED	54993.34	7041.18	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	49753.63	.	1.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GRAB	51756.83	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	56558.60	.	1.00	.	.	0.00

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CMG MEAN	CMG STD	CMG N	OMG MEAN	OMG STD	OMG N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	10929.80	.	1.00	*	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	103327.96	30059.31	2.00	.	.	0.00
			MIXED	39544.23	*	-.00	.	.	0.00
			ORGANIC	12937.69	.	1.	.	.	0.00
			SOIL	4737.22	*	1.00	*	.	0.00
			GRAB	37722.47	6308.07	2.00	*	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	23254.80		00		.	0.00
			CLAY	76665.88	.	00		.	0.0W
			GRAB	29159.95	4225.23	2.00	51185.88	29265.01	2.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	0.00	.	1.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	6241.98	.	1.00	27563.90	.	1.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	17121.97	.	1.00	*	.	0.00
			GITZ	4778.92	1685.24	2.00	*	.	0.00
			CLAY	0.00	.	1.00	.	.	0.00
			GRAB	12272.69	12549.25	3.00	*	.	0.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	26620.13	13442.12	2.00	*	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	*	0.00	35417.91	.	1.00
			FINES	38132.48	.	1.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	0.00	56494.94	33363.83	2.00
			FINES	27912.92	.	1.00	.	.	0.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7.

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CMG MEAN	CMG STD	CMG N	DMG MEAN	DMG STD	DMG N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	16990.87	.	1.00	.	.	0.00
			GRAB	27736.82	9960.96	6.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	0.00	83236.25	.	1.00
			FINES	43583.73	.	1.00	.	.	0.00
			ORGANIC	26467.03	.	1.00	.	.	0.00
		UNKNOWN	COARSE	42041.09	.	1.00	.	.	0.00
			FINES	36783.74	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	98409.11	.	1.00
			FINES	9727.02	.	1.00	85512.23	.	1.00
			GRAB	28407.00	.	1.00	79864.96	7940.51	2.00
		20-25 CM DEEP	COARSE	22635.97	4980.72	2.00	76848.08	.	1.00
			FINES	28296.24	2743.77	2.00	108992.02	.	1.00
			ORGANIC	30328.63	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	34153.55	.	1.00	.	.	0.00
			MIXED	47667.87	12046.65	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	16427.86	.	1.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GROB	16680.90	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFAC	GRAB	7308.21	.	1.00	.	.	0.00

SURLOC	SAMPTYPE	SAMPID	TEXTURE	CMN MEAN	CMN STD	CMN N	DMN MEAN	DMN STD	DMN N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	443.40	.	1.00	.	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	31941.69	93.53	2.00	.	.	0.00
			MIXED	15549.85	.	1.00	.	.	0.00
			ORGANIC	8460.57	.	1.00	.	.	0.00
			SOIL	1024.86	.	1.00	.	.	0.00
			GRAB	13241.65	350.12	2.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	22701.81	.	1.00	.	.	0.00
			CLAY	24971.25	.	1.00	.	.	0.00
			GRAB	17660.86	1934.74	4.00	.	.	0.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	690.62	.	1.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	10733.44	9681.01	2.00	.	.	0.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	9574.73	.	1.00	.	.	0.00
			GITZ	488.58	20.23	2.00	.	.	0.00
			CLAY	1064.48	.	1.00	.	.	0.00
			GRAB	8077.22	11235.36	3.00	.	.	0.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	823.59	146.36	2.00	.	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	21341.42	.	1.00	.	.	0.00
			FINES	18596.61	.	1.00	.	.	0.00
		20-25 CM DEEP	COARSE	21692.26	2534.07	2.00	.	.	0.00
			FINES	11735.97	.	1.00	.	.	0.00

(CONTINUED)

				CMN			DMN		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	1526.46	.	1.00	.	.	0.00
			GRAB	562.09	557.75	7.00	.	.	0.00
		20-25 CM DEEP	COARSE	25723.37	.	1.00	.	.	0.00
			FINES	4946.08	.	1.00	.	.	0.00
			ORGANIC	1545.58	.	1.00	.	.	0.00
		UNKNOWN	COARSE	481.87	.	1.00	.	.	0.00
			FINES	1870.86	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	37584.99	.	1.00	.	.	0.00
			FINES	15317.52	21175.79	2.00	.	.	0.00
			GRAB	15099.09	12722.51	3.00	.	.	0.00
		20-25 CM DEEP	COARSE	8859.20	14728.25	3.00	.	.	0.00
			FINES	26588.40	11645.86	3.00	.	.	0.00
			ORGANIC	1593.58	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	1560.95	.	1.00	.	.	0.00
			MIXED	1825.06	376.51	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	8234.96	.	1.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GRAB	1620.09	.	1.00	.	.	0.01
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	5069.30	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CBA MEAN	CBA STD	CBA N	DBA MEAN	DBA STD	DBA N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	2285.45	.	1.00	.	.	0.00
			GRAB	895.81	924.72	3.00	944.49	1171.37	4.00
		20-25 CM DEEP	COARSE	14858.34	.	1.00	.	.	0.00
			FINES	2722.83	.	1.00	.	.	0.00
			ORGANIC	1301.96	.	1.00	.	.	0.00
		UNKNOWN	COARSE	1682.86	.	1.00	.	*	0.00
			FINES	2060.74	.	1.00	.	*	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	16443.91	.	1.00	.	*	0.00
			FINES	6800.49	8857.34	2.00	.	.	0.00
			GRAB	.	.	0.00	6235.28	5121.48	3.00
		20-25 CM DEEP	COARSE	4713.96	6964.05	3.00	.	.	0.00
			FINES	10942.19	8657.94	2.00	2579.71	.	1.00
			ORGANIC	1552.93	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	1879.16	.	1.00	.	.	0.00
			MIXED	1937.01	355.57	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	2023.96	.	1.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GRAB	1193.07	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	2879.04	.	1.00	.	.	0.00

PWRT RADIUM :ATA DUMP OF 1982 AND 1983 TAILING SAMPLE DATA

				CCA			O A		
				MEAN	D	N	MEAN	S D	N
SUBLOC	SAMPT-YPE	SAMPID	TEXTURE						
SHAFT CNTL SOIL	SOIL	SURFA-CE	GRAB	.	.	0.00	3624.64	.	1.00
GARBA-GE LAKE	BARE TAILI-NGS	SUBME-RGED TAILS	FINES	82554.13	.	1.00	24324.10	.	1.00
			MIXED	51422.96	.	1.00	.	.	0.00
			ORGANIC	30939.94	.	1.00	.	.	0.00
			SOIL	11640.04	.	1.00	.	.	0.00
			GRAB	40911.98	10264.18	2.00	.	.	0.00
COBALT CHANN-EL	SEDIM-ENT	LAKE SEDIM-ENTS	FINES	56260.14	.	1.00	.	.	0.00
			CLAY	46748.47	.	1.00	.	.	0.00
			GRAB	37658.11	5655.23	4.00	.	.	0.00
BEAR BAY	SEDIM-ENT	LAKE SEDIM-ENTS	GRAB	11400.02	.	1.00	.	.	0.00
BEAR CREEK	BARE TAILI-NGS	SURFA-CE	GRAB	16408.86	4957.45	2.00	.	.	0.00
LABINE BAY	SEDIM-ENT	LAKE SEDIM-ENTS	FINES	19754.51	.	1.00	.	.	0.00
			GITZ	9340.32	914.47	2.00	.	.	0.00
			CLAY	10959.15	.	1.00	.	.	0.00
			GRAB	16189.48	7361.51	3.00	.	.	0.00
MURPHY BAY	SEDIM-ENT	SURFA-CE	GRAB	15676.75	4316.28	2.00	.	.	0.00
SILVER POINT	BARE TAILI-NGS	SURFA-CE	COARSE	54117.40	.	1.00	.	.	0.00
			FINES	49019.42	.	1.00	.	.	0.00
		20-25 CM	COARSE	49321.00	9631.76	2.00	.	.	0.00
		DEEP	FINES	437 .17	.	1.00	.	.	0.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 AND 1983 TAILING SAMPLE DATA

12:13 THURSDAY, APRIL

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CCA MEAN	CCA STD	CCA N	DCA MEAN	DCA STD	DCA N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	13517.43	.	1.00	.	.	0.00
			GRAB	37121.57	49123.26	6.00	.	.	0.00
		20-25 CM DEEP	COARSE	47519.17	.	1.00	.	.	0.00
			FINES	39822.26	.	1.00	.	.	0.00
			ORGANIC	12396.96	.	1.00	.	.	0.00
		99	COARSE	14138.79	.	1.00	.	.	0.00
			FINES	19750.42	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	63127.86	.	1.00	.	.	0.00
			FINES	32605.98	33866.30	2.00	.	.	0.00
			GRAB	26796.43	20640.04	2.00	63068.34	.	1.00
		20-25 CM DEEP	COARSE	46613.31	23046.87	3.00	.	.	0.00
			FINES	49643.83	.	1.00	35197.25	31320.98	2.00
			ORGANIC	34141.91	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	26523.50	.	1.00	.	.	0.00
			MIXED	30804.22	5758.36	4.00	.	.	0.00
PARKING LOT	SEDIMENT	SURFACE	COARSE	15249.80	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	13706.83	.	1.00	.	.	0.00

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLUC	SAMPTYPE	SAMPID	TEXTURE	CVA MEAN	CVA STD	CVA N	DVA MEAN	DVA STD	DVA N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	102.72	.	1.00	.	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	729.56	.	1.00	616.10	.	1.00
			MIXED	443.65	.	1.00	.	.	0.00
			ORGANIC	213.34	.	1.00	.	.	0.00
			SOIL	61.91	.	1.00	.	.	0.00
			GRAB	329.18	32.83	2.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	321.34	.	1.00
			CLAY	.	.	0.00	345.65	.	1.00
			GRAB	324.96	111.57	2.00	161.78	27.13	2.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	95.23	.	1.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	132.46	19.71	2.00	.	.	0.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	370.80	.	1.00	.	.	0.00
			G TZ	102.3	9.92	2.00	.	.	0.00
			CLAY	96.6	.	1.00	.	.	0.00
			GRAB	179.59	83.72	3.00	.	.	0.00
MURPHO BAY	SEDIMENT	SURFACE	GRAB	392.21	51.24	2.00	.	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	195.30	.	1.00	.	.	0.00
			FINES	337.57		1.00	.	.	0.00
		20-25 CM DEEP	COARSE	206.18	.	1.00	278.00	.	1.00
			FINES	114.11	.	1.00	.	.	0.00

(CONTINUED)

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CVA MEAN	CVA STD	CVA N	DVA MEAN	DVA STD	DVA N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	548.75	.	1.00	.	.	0.00
			GRAB	396.89	130.19	7.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	0.00	289.95	.	1.00
			FINES	559.99	.	1.00	.	.	0.00
			ORGANIC	118.39	.	1.00	.	.	0.00
		UNKNOWN	COARSE	747.11	.	1.00	.	.	0.00
			FINES	636.48	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	399.88	.	1.00
			FINES	423.05	45.68	2.00	.	.	0.00
			GRAB	443.40	148.99	3.00	.	.	0.00
		20-25 CM DEEP	COARSE	398.85	41.76	3.00	.	.	0.00
			FINES	254.25	28.93	2.00	667.38	.	1.00
			ORGANIC	231.06	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	480.67	.	1.00	.	.	0.00
			MIXED	506.88	31.52	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	82.39	.	1.03
	PROCESS SLIMES	SURFACE	GRAD	162.24	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	76.31	.	1.00	.	.	0.00

				CNA			DNA		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	26271.67	.	1.00	.	.	0.00
GARBAGE LAKE	HARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	8360.92	31.18	2.00
			MIXED	2883.42	.	1.00	.	.	0.00
			ORGANIC	9754.42	.	1.00	.	.	0.00
			SOIL	21992.02	.	1.00	.	.	0.00
			GRAB	5507.93	1267.00	2.00	.	.	0.00
COBALT CHANNEL	SEDIMENT	CAKE SEDIMENTS	FINES	7702.39	.	1.00	.	.	0.00
			CLAY	.	.	0.00	6397.30	.	1.00
			GRAB	15818.28	4336.91	4.00	.	.	0.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	17103.69	.	1.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	14237.48	2671.89	2.00	.	.	0.00
LABINE RAY	SEDIMENT	LAKE SEDIMENTS	FINES	9090.38	.	1.00	.	.	0.00
			GITZ	11873.22	211.43	2.00	.	.	0.00
			CLAY	18150.10	.	1.00	.	.	0.00
			GRAB	11524.51	4939.39	3.00	.	.	0.00
MURPHY HAY	SEDIMENT	SURFACE	GRAB	2095.88	115.29	2.00	.	.	0.00
SILVER POINT	HARE TAILINGS	SURFACE	COARSE	12616.53	.	1.00	.	.	0.00
			FINES	12086.04	.	1.00	.	.	0.00
		20-25 CM DEEP	COARSE	14661.41	1256.44	2.00	.	.	0.00
			FINES	17957.48	.	1.00	.	.	0.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7, 1

				CNA			DNA		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	3894.71	.	1.00	.	.	0.00
			GRAB	2841.61	1658.52	7.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	0.00	6211.20	.	1.00
			FINES	3758.87	.	1.00	.	.	0.00
			ORGANIC	4212.43	.	1.00	.	.	0.00
		UNKNOWN	COARSE	1523.39	.	1.00	.	.	0.00
			FINES	2902.95	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	7968.40	.	1.00
			FINES	3082.25	.	1.00	7214.65	.	1.00
			GRAB	2208.50	.	1.00	6243.16	575.41	2.00
		20-25 CM DEEP	COARSE	1724.57	60.91	2.00	6741.03	.	1.00
			FINES	5699.13	2145.67	2.00	7882.36	.	1.00
			ORGANIC	997.18	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	2577.93	.	1.00	.	.	0.00
			MIXED	2569.34	504.82	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	13608.93	.	1.00	.	.	0.00
	PROCESS SLIMES	SURFACE	GRAB	16673.52	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	17069.55	.	1.00	.	.	0.00

PORT [illegible]IUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7

				CCL			DCL		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	0.00	357.45	.	1.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	2479.18	12.14	2.00
			MIXED	.	.	0.00	826.51	.	1.00
			ORGANIC	.	.	0.00	793.80	.	1.00
			SOIL	420.88	.	1.00	.	.	0.00
			GRAB	.	.	0.00	863.12	120.14	2.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	1342.48	.	1.00
			CLAY	.	.	0.00	2556.14	.	1.00
			GRAB	.	.	0.00	1323.14	371.41	4.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	0.00	330.29	.	1.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	882.74	345.25	2.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	714.87	.	1.00
			GITZ	240.80	.	1.00	185.70	.	1.00
			CLAY	343.83	.	1.00	.	.	0.00
			GRAB	.	.	0.00	588.08	533.60	3.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	325.96	30.28	2.00	.	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	1370.73	.	1.00
			FINES	.	.	0.00	1286.31	.	1.00
		20-25 CM DEEP	COARSE	.	.	0.00	1337.63	341.13	2.00
			FINES	.	.	0.00	987.77	.	1.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7.

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CCL MEAN	CCL STD	CCL N	DCL MEAN	DCL STD	DCL N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	443.56	.	1.00
			GRAB	232.92	61.97	3.00	223.79	34.1	3.00
		20-25 CM DEEP	COARSE	.	.	0.00	2055.46	.	1.00
			FINES	.	.	0.00	689.55	.	1.00
			ORGANIC	.	.	0.00	511.87	.	1.00
		UNKNOWN	COARSE	297.17	.	1.00	.	.	0.00
			FINES	.	.	0.00	643.56	.	1.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	2594.99	.	1.00
			FINES	420.71	.	1.00	2079.29	.	1.00
			GRAB	1506.23	1494.11	2.00	2461.75	.	1.00
		20-25 CM DEEP	COARSE	222.40	13.40	2.00	2413.81	.	1.00
			FINES	.	.	0.00	1988.05	1289.5+	3.00
			ORGANIC	201.74	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	251.75	.	1.00
			MIXED	.	.	0.00	436.91	113.08	4.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	777.91	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	.	.	000	185.78	.	1.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	000	655.65	.	1.00

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CBA MEAN	CBA STD	CBA N	DBA MEAN	DBA STD	DBA N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	741.21	.	1.00	.	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	9847.33	19.14	2.00
			MIXED	.		0.00	3069.19	.	1.00
			ORGANIC	0983.00	.	1.00	.	.	0.00
			SOIL	976.65	.	1.00	.	.	0.00
			GRAB	.	.	0.00	2216.01	45.52	2.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	4491.00	.	1.00	.	.	0.00
			CLAY	.	.	0.00	11484.04	.	1.00
			GRAB	5930.72	3561.14	3.00	3044.05	.	1.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	1208.27	*	1.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	3493.84	1500.93	2.00	.	.	0.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	2628.90	.	1.00	.	.	0.00
			GITZ	1020.24	48.28	2.00	.	.	0.00
			CLAY	1213.62	.	1.00	.	.	0.00
			GRAB	2175.78	1566.17	3.00	.	.	0.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	1090.07	.	1.00	544.18	.	1.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	*	.	0.00	3094.31	.	1.00
			FINES	.	.	0.00	2929.93	.	1.00
		20-25 CM DEEP	COARSE	.	.	0.00	5916.19	4668.62	2.00
			FINES	.	.	0.00	2000.28	.	1.00

(CONTINUED)

				CI			DI		
				MEAN	STD	N	MEAN	STD	N
SURLOC	SAWPT-YPE	SAMPID	TEXTURE						
SHAFT CNTL SOIL	SOIL	SURFA-CE	GRAB	.	.	0.00	1.59	.	1.00
GARBA-GE LAKE	BARE TAILI-NGS	SUBME-RGED TAILS	FINES	.	.	0.00	42.92	2.58	2.00
			MIXED	.	.	0.00	12.72	.	1.00
			ORGANIC	.	.	0.00	8.33	.	1.00
			SOIL	.	.	0.00	1.80	.	1.00
			GRAB	.	.	0.00	12.89	0.27	2.00
COBALT CHANN-EL	SEDIM-ENT	LAKE SEDIM-ENTS	FINES	.	.	0.00	16.00	.	1.00
			CLAY	.	.	0.00	37.47	.	1.00
			GRAB	.	.	0.00	18.44	7.55	4.00
BEAR BAY	SEDIM-ENT	LAKE SEDIM-ENTS	GRAB	.	.	0.00	1.78	.	1.00
BEAR CREEK	BARE TAILI-NGS	SURFA-CE	GRAB	.	.	0.00	10.14	4.89	2.00
LABINE BAY	SEDIM-ENT	LAKE SEDIM-ENTS	FINES	.	.	0.00	9.97	.	1.00
			SITZ	15.95	.	1.00	1.53	.	1.00
			CLAY	.	.	0.00	2.19	.	1.00
			GRAB	.	.	0.00	7.01	8.02	3.00
MURPHY DAY	SEDIM-ENT	SURFA-CE	GRAB	.	.	0.00	19.67	0.89	2.00
SILVER POINT	BARE TAILI-NGS	SURFA-CE	COARSE	.	.	0.00	16.17	.	1.00
			FINES	.	.	0.00	15.10	.	1.00
		20-25 CM DEEP	COARSE	.	.	0.00	24.36	13.31	2.00
			FINES	.	.	0.00	11.29	.	1.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CI MEAN	CI STD	CI N	DI MEAN	DI STD	DI N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	4.65	.	1.00
			GRAB	.	.	0.00	1.72	0.61	6.00
		20-25 CM DEEP	COARSE	.	.	0.00	343.96	.	1.00
			FINES	.	.	0.00	71.56	.	1.00
			ORGANIC	.	.	0.00	4.03	.	1.00
		UNKNOWN	COARSE	.	.	0.00	2.13	.	1.00
			FINES	.	.	0.00	5.31	.	1.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	398.27	.	1.00
			FINES	.	.	0.00	193.80	252.68	2.00
			GRAB	.	.	0.00	231.57	189.66	3.00
		20-25 CM DEEP	COARSE	.	.	0.00	132.72	208.87	3.00
			FINES	.	.	0.00	269.43	202.11	3.00
			ORGANIC	.	.	0.00	23.93	.	1.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	26.63	.	1.00
			MIXED	.	.	0.00	48.12	14.94	4.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	99.03	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	.	.	0.00	23.51	.	1.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	7.47	.	1.00

Description of tailings data

Variable	Description	Unit	Lab	1982 Detection Limit
CBA	Ba concentration*	µg/g	SLOWPOKE	variable
EBA	Error of Ba am centration*	µg/g	SLOWPOKE	na
BACODE	Code of Ba*	na	SLOWPOKE	na
CSR	Sr concentration*	µg/g	SLOWPOKE	variable
ESR	Error of Sr concentration*	µg/g	SLOWPOKE	na
SRCODE	Code of Sr	na	SLOWPOKE	na
CI	I concentration*	µg/g	SLOWPOKE	variable
EI	Error of I concentration*	µg/g	SLOWPOKE	na
ICODE	Code of I*	na	SLOWPOKE	na
CBR	Br concentration*	µg/g	SLOWPOKE	variable
EBR	Error of Br concentration*	µg/g	SLOWPOKE	na
BRCODE	Code of Br*	na	SLOWPOKE	na
CMG	Mg concentration*	µg/g	SLOWPOKE	variable
EMG	Error of Mg amcentration*	µg/g	SLOWPOKE	na
MCCODE	Code of Mg*	na	SLOWPOKE	na
CNA	Na concentration	µg/g	SLOWPOKE ·	variable
ENA	Emr of Na concentration*	µg/g	SLOWPOKE	na
NACODE	Code of Na*	na	SLOWPOKE	na
CVA	Va concentration	µg/g	SLOWPOKE	variable
EVA	Error of Va concentration*	µg/g	SLOWPOKE	na
VACODE	Code of Va*	na	SLOWPOKE	na
CAL	Al concentration*	µg/g	SLOWPOKE	variable
EAL	Error of Al concentration*	µg/g	SLOWPOKE.	na
ALCODE	Code of Al*	na	SLOWPOKE	na

POP▶ RADIUM DATA DUMP WF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CBR MEAN	CBR STD	CBR N	DBR MEAN	DBR STD	DBR N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	0.00	52.59	.	1.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	185.49	14.06	2.00
			MIXED	.	.	0.00	47.65	.	1.00
			ORGANIC	.	.	0.00	35.20	.	1.00
			SOIL	.	.	0.00	7.29	.	1.00
			GRAB	.	.	0.00	57.69	2.52	2.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	614.76	.	1.00
			CLAY	.	.	0.00	1715.83	.	1.00
			GRAB	.	.	0.00	684.75	25[illegible].86	4.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	0.00	65.11	.	1.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	381.72	196.41	2.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	0.00	370.09	.	1.00
			GITZ	.	.	0.00	51.60	1.08	2.00
			CLAY	.	.	0.00	82.22	.	1.00
			GRAB	.	.	0.00	261.81	302.76	3.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	.	.	0.00	67.22	5.90	2.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	62.73	.	1.00
			FINES	.	.	0.00	58.64	.	1.00
		20-25 CM DEEP	COARSE	.	.	0.00	95.30	40.76	2.00
			FINES	.	.	0.00	50.07	.	1.00

(CONTINUED)

PONT RADIUM DATA UMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CBR MEAN	CBR STD	CBR N	DBR MEAN	DBR STD	DBR N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	16.42	.	1.00
			GRAB	.	.	0.00	6.60	2.69	6.00
		20-25 CM DEEP	COARSE	.	.	0.00	1231.11	.	1.00
			FINES	.	.	0.00	290.57	.	1.00
			ORGANIC	.	.	0.00	15.62	.	1.00
		UNKNOWN	COARSE	.	.	0.00	7.87	.	1.00
			FINES	.	.	0.00	21.80	.	1.00
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	1604.52	.	1.00
			FINES	.	.	0.00	699.28	917.49	2.00
			GRAB	.	.	0.00	844.05	682.03	3.00
		20-25 CM DEEP	COARSE	.	.	0.00	471.84	736.48	3.00
			FINES	.	.	0.00	1028.11	763.82	3.00
			ORGANIC	.	.	0.00	83.19	.	1.00
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	95.34	.	1.00
			MIXED	.	.	0.00	159.83	47.98	4.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	372.34	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	.	.	0.00	85.93	.	1.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	280.04	.	1.00

GORT RADIUM DATA DUMP UC 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7,

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	COY MEAN	COY STD	COY N	OOY MEAN	OOY STD	OOY N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	0.04	.	1.00	.	.	0.00
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	0.00	12.74	0.02	2.00
			MIXED	2.79	.	1.00	.	.	0.00
			ORGANIC	.	.	0.00	2.57	.	1.00
			SOIL	1.82	.	1.00	.	.	0.00
			GRAB	*	*	0.00	2.68	0.08	2.00
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	0.35	.	1.00	.	.	0.00
			CLAY	.	.	0.00	1.09	.	1.00
			GRAB	.	.	0.00	0.43	0.35	4.00
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	0.10	.	1.00	.	.	0.00
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	0.00	0.20	0.05	2.00
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	0.38	.	1.00	.	.	0.00
			GITZ	0.15	0.02	2.00	.	.	0.00
			C AY	0.10	.	1.00	.	.	0.00
			GRAB	0.24	0.10	3.00	.	.	0.00
MURPHY BAY	SEDIMENT	SURFACE	GRAB	3.77	2.04	2.00	.	.	0.00
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	.	0.00	2.65	.	1.00
			FINES	3343	.	1.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	0.00	7.25	5.78	2.00
			FINES	.	.	0.00	2.45	.	1.00

(CONTINUED)

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	CDY MEAN	CDY STD	CDY N	DDY MEAN	DDY STD	DDY N
WEST AUDIT	BARE TAILINGS	SURFACE	CCARSE	4.28	.	1.00	.	.	0.00
			GRAB	4.60	3.22	7.00	.	.	0.00
		20-25 CM DEEP	COARSE	.	.	0.00	11.05	.	1.00
			FINES	4.91	*	1.00	.	.	0.00
			ORGANIC	7.82	.	1.00	.	.	0.00
		UNKNOWN	COARSE	4.19	*	1.00	.	.	0.00
			FINES	6.31	.	1.00	.	.	0.00
MURPHY LAKE	BARE TAILINGS	SURFACE	CCARSE	.	-	0.00	18.81	.	1.00
			FINES	6.00	.	1.00	10.39	.	1.00
			GRAB	2.73	.	1.00	11.05	1.09	2.00
		20-25 CM DEEP	COARSE	3.99	0.71	2.00	10.91	.	1.00
			FINES	2.30	.	1.00	8.01	7.11	2.00
			ORGANIC	1.67	.	1.00	.	.	0.00
MURPHY CREEK	BARE TAILINGS	SURFACE	CCARSE	3.96	.	1.00	.	.	0.00
			MIXED	4.02	0.38	4.00	.	.	0.00
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	0.00	2.26	.	1.00
	PROCESS SLIMES	SURFACE	GRAB	1.30	.	1.00	.	.	0.00
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	0.18	.	1.00	.	.	0.00

Description of tailings data.

Variable	Description	Unit	1982 Lab	1982 Det. Limit	1983 Lab	1983 Det. Limit
OBS	Observation	na	na	na	-	-
SITE	Site: Control (K), Port Radium (R)	na	na	na	-	-
AREA	Area within site.	na	na	na	-	-
AMEND	Type of site amendment	na	na	na	-	-
SAMPTYPE	General sample type.	na	na	na	-	-
SAMPID	Depth/Description of sample type.	na	na	na	-	-
RNUM	Replicate number	na	na	na	-	-
PH	pH	$-\log[H^+]$	field	na	-	-
CONDO	Conductivity	μmhos/cm	field	na	-	-
MOIST	% moisture	% by weight	*IES*[1]	na	-	-
LOI	% Lost on Ignition	% by weight	*IES*[1]	na	-	-
CC02	C_o concentration*	$\mu g/g$	*SLOWPOKE*[2]	variable	-	-
EC02	Error of C_o concentration*	$\mu g/g$	SLOWPOKE	na	-	-
CO2CODE	code of C_o	na	SLOWPOKE	na	-	-
CU	U concentration*	$\mu g/g$	SLOWPOKE	variable	-	-
EU	Error of U concentration*	$\mu g/g$	SLOWPOKE	na	-	-
UCODE	code of U*	na	SLOWPOKE	na	-	-
CDY	Dy concentration*	$\mu g/g$	SLOWPOKE	variable		
EDY	Error of Dy concentration*	$\mu g/g$	SLOWPOKE	na	-	-
DYCODE	Code of Dy*	na	SLOWPOKE	na	-	-

Description of tailings data

Variable	Description	Unit	Lab	1982 Detection Limit
CMN	Mn concentration*	µg/g	SLOWPOKE	variable
EMN	Error of Mn concentration*	µg/g	SLOWPOKE	na
MNCODE	Code of Mn*	na	SLOWPOKE	na
CCL	Cl concentration*	µg/g	SLOWPOKE	variable
ECL	Error of Cl concentration*	µg/g	SLOWPOKE	na
CLCODE	Code of Cl*	na	SLOWPOKE	na
CCA	Ca concentration*	µg/g	SLOWPOKE	Variable
ECA	Error of Ca concentration*	µg/g	SLOWPOKE	na
CACODE	Code of Ca*	na	SLOWPOKE	na
DATE	Year of sampling	na	na	na
SUBAREA	Subarea	na	na	na
TEXTURE	Type of Sampling /Texture of Sample	na	na	na
SUBLOC	Site and Area	na	na	na
DC02	Co detection limit*	µg/g	SLOWPOKE	variable
DDY	Dy detection limit*	µg/g	SLOWPOKE	variable
DBA	Ba detection limit*	µg/g	SLOWPOKE	Variable
DSR	Sr detection limit*	µg/g	SLOWPOKE	variable
DI	I detection limit*	µg/g	SLOWPOKE	variable
DBK	Br detection limit*	µg/g	SLOWPOKE	Variable
DMG	Mg detection limit*	µg/g	SLOWPOKE	variable
DNA	Na detection limit*	µg/g	SLOWPOKE	Variable
DVA	Va detection limit*	µg/g	SLOWPOKE	Variable

Description of tailings data

Variable	Description	Unit	Lab	1982 Detection Limit
DAL	A1 detection limit,	μg/g	SLOWPOKE	variable
DMN	Mn detection limit'	μg/g	SLOWPOKE	variable
DCL	Cl detection limit'	μg/g	SLOWPOKE	variable
DCA	Ca detection limit*	μg/g	SLOWPOKE	variable

*For each element analyzed at the SLOWPOKE Facility at the University of Toroto, four variables are produced, these being concentrati'on, error, aide, and detection limit. If the code= 0, then an actual concentrati'on and its error are missing, while a value is present under detection limit If the code= 1, then an actual concentration plus error are included, while no detection limit exists. A code of 2 means analysis was not performed for that sample.

1 = University of Toronto
na = not available

Heavy Metal Analysis (Diand) of Port Radium Solid Samples: Copper and Iron

				Cu			Fe		
SUBLOC	SAMPTYPE	SAMPID	TEXTURE	MEAN	STD	N	MEAN	STD	N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	.	.	.	.
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
			SOIL	.	.	.	.	.	.
			GRAB	950.00	28.28	2	65,895.00	12,621.85	2
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	.	.	.	.
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			GITZ	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	1,765.00	2,227.37	2	29,055.00	4,292.14	2
		SURFACE	GRAB	5,750.00	.	1	41,300.00	.	1
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	4,490.00*	272.21	1	40,770.00*	2,632.17	1
			FINES	.	.	.	.	.	.

(CONTINUED)

* Mean and S.D. derived from replicate analysis of single sample.

				Cu			Fe		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPIO	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	3,400.00	814.31	3	34,420.00	5,240.39	3
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	6,225.00	2,239.44	2	45 512 50	5 982	2
			FINES	.	.	.		.	.
			ORGANIC	30,700.00	.	1	22,650.00		1
		UNKNOWN	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	.	.	.	.
	PROCESS SLIMES	SURFACE	GRAB	.	.	.	.	.	.
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.

Heavy Metal Analysis (Diand) of Port Radium Solid Samples: Arsenic and Cadmium

				As			Cd		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB	.	.	.	.	.	.
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
			SOIL	.	.	.	.	.	.
			GRAB	1,553.00	130.11	2	0.43	0.14	2
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	.	.	.	.
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			SILTZ	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	572.50	744.58	2	0.35	0.23	2
SILVER POINT	BARE TAILINGS	SURFACE	GRAB	2,163.00		1	1.30		
		SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	2,142.66*	102.71	1	0.83*	0.06	1
			FINES	.	.	.	.	.	.

(CONTINUED)

* Mean and 5.0. derived from replicate analysis of single sample.

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	As MEAN	As STD	As N	Cd MEAN	Cd STD	Cd N
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	3,253.33	471.27	3	0.27	0.26	3
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	1,958.00	1,177.91	2	2.14	1.28	2
			FINES	.	.	.	.	.	.
			ORGANIC	1,275.00	.	1	0.12	.	2
		UNKNOWN	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	.	.	.	.
	PROCESS SLIMES	SURFACE	GRAB	.	.	.	.	.	.
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.

Heavy Metal Analysis (Diand) of Port Radium Solid Samples: Lead and Mercury

SUBLOC	SAMPTYPE	SAMPID	TEXTURE	Pb MEAN	Pb STD	Pb N	Hg MEAN	Hg STD	Hg N
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB						
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
			SOIL	.	.	.	.	.	.
			GRAB	1,475.50	515.48	2	1.10	0.00	2
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	.	.	.	.
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			SILTZ	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	132.00	140.00	2	00.28	00.32	2
		SURFACE	GRAB	1,440.00	.	1	3.5	.	1
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	1,277.67*	27.15	1	2.6	.	1
			FINES	.	.	.	.	.	.

(CONTINUED)

				Pb			Hg		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	359.33	80.90	3	1.17	0.21	3
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	632.50*	197.35	2	1.00	00.28	2
			FINES	.	.	.	.	.	.
			ORGANIC	83.00	.	1	.	.	.
		UNKNOWN	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
PARKING LOT	OVERBURDEN	SURFACE	COARSE						
	PROCESS SLIMES	SURFACE	GRAB	.	.	.	.	.	.
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.

* Mean and S.D. derived from replicate analysis of single sample.

Heavy Metal Analysis (Diand) of Port Radium Solid Samples: Zinc and Cobalt*

				Zn			Co		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
SHAFT CNTL SOIL	SOIL	SURFACE	GRAB						
GARBAGE LAKE	BARE TAILINGS	SUBMERGED TAILS	FINES	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
			SOIL	.	.	.	.	.	.
			GRAB	572.50	183.14	2	225.50	12.02	2
COBALT CHANNEL	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
BEAR BAY	SEDIMENT	LAKE SEDIMENTS	GRAB	.	.	.	.	.	.
BEAR CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.
LABINE BAY	SEDIMENT	LAKE SEDIMENTS	FINES	.	.	.	.	.	.
			SILT	.	.	.	.	.	.
			CLAY	.	.	.	.	.	.
			GRAB	184.00	98.99	2	300.00	393.15	2
		SURFACE	GRAB	1,450.00	.	1	562.00	.	1
SILVER POINT	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	833.00*	7.55	1	235.33*	26.54	1
			FINES	.	.	.	.	.	.

(CONTINUED)

				Zn			Co		
				MEAN	STD	N	MEAN	STD	N
SUBLOC	SAMPTYPE	SAMPID	TEXTURE						
WEST AUDIT	BARE TAILINGS	SURFACE	COARSE	290.67	153.08	3	331.67	486.16	.
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	1,479.00	828.17	2	1,364.00	915.26	2
			FINES	.	.	.	.	.	.
			ORGANIC	482.00	.	1	542.00	.	1
		UNKNOWN	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
MURPHY LAKE	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			GRAB	.	.	.	.	.	.
		20-25 CM DEEP	COARSE	.	.	.	.	.	.
			FINES	.	.	.	.	.	.
			ORGANIC	.	.	.	.	.	.
MURPHY CREEK	BARE TAILINGS	SURFACE	COARSE	.	.	.	.	.	.
			MIXED	.	.	.	.	.	.
PARKING LOT	OVERBURDEN	SURFACE	COARSE	.	.	.	.	.	.
	PROCESS SLIMES	SURFACE	GRAB	.	.		.	.	.
GARBAGE CREEK	BARE TAILINGS	SURFACE	GRAB	.	.	.	.	.	.

* Mean and S D deri ed from replicate analysis of single sample

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAREA	AMEND	SAMPTYPE	SAMPID	RNUM	PH	COND	MOIST	LOI	CRA	ERA	CPB210	EPB210	CPB	CNI	CCU	CCO	CCO2	ECO2	CCO2CODE
1	K	02	N	.	.	.	NO AMENDMENT	SOIL	SURFACE	.	3.1	1200	1.2	11.6	.	.	.	.	.	.	.	.	.	.	0
2	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	1	8.0	140	.	6.3	.	.	.	.	.	.	.	.	.	.	0
3	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	2	8.0	140	.	3.2	.	.	.	.	.	.	.	.	.	.	0
4	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	1	8.4	170	.	3.0	.	.	.	.	.	.	.	.	.	.	2
5	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	2	8.4	170	.	1.7	.	.	.	.	.	.	.	.	160.94	20.7484	1
6	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	.	8.0	140	.	12.7	.	.	.	.	.	.	.	.	80.91	16.0766	1
7	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	.	8.0	140	.	3.9	.	.	.	.	.	.	.	.	36.24	4.2677	1
8	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	1	.	.	.	4.3	.	.	.	.	.	.	.	.	.	.	0
9	R	01	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SUBMERGED TAILS	2	.	.	.	1.1	.	.	.	.	.	.	.	.	76.72	19.2337	1
10	R	02	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	8.6	150	.	3.0	.	.	.	.	.	.	.	.	.	.	0
11	R	02	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	8.6	150	.	1.9	.	.	.	.	.	.	.	.	.	.	0
12	R	02	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	7.5	70	.	6.5	.	.	.	.	.	.	.	.	143.05	24.5760	1
13	R	02	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	7.5	70	.	1.2	.	.	.	.	.	.	.	.	164.41	21.4062	1
14	R	02	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	7.9	110	.	2.4	.	.	.	.	.	.	.	.	.	.	0
15	R	02	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	7.9	80	.	3.6	.	.	.	.	.	.	.	.	168.79	18.4994	1
16	R	03	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	.	.	.	0.3	.	.	.	.	.	.	.	.	36.68	4.3356	1
17	R	04	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.3	810	0.5	.	.	.	.	.	.	.	.	.	.	.	0
18	R	04	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	6.9	1100	[illegible]1	8.1	.	.	.	.	.	.	.	.	167.91	19.5111	1
19	R	05	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	7.6	80	.	1.7	.	.	.	.	.	.	.	.	179.40	18.5141	1

OBS	CU	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	FI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE	CNA
1	2.69	0.7788	1	0.0446	0.013469	1	741.21	138.90	1	.	.	2	.	.	0	.	.	0	.	.	0	10930	964.3	1	20271.7
2	112.82	15.6481	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	92073	29216.9	1	.
3	107.33	16.3401	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	124583	35331.8	1	.
4	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.	.	2	.
5	103.69	3.8054	1	2.7900	0.830862	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	39544	7853.9	1	2563.4
6	638.04	4.2111	1	.	.	0	6983.00	550.90	1	.	.	2	.	.	0	.	.	0	.	.	0	12938	3355.5	1	9754.4
7	47.91	0.9822	1	1.8200	0.221312	1	976.65	141.22	1	.	.	2	.	.	0	.	.	0	.	.	0	4737	443.8	1	21992.7
8	42.19	3.2824	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	42183	8920.6	1	4612.0
9	75.91	3.4387	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	33262	9117.4	1	6403.9
10	154.41	4.7867	1	0.3310	0.083577	1	4491.00	970.06	1	.	.	2	.	.	0	.	.	0	.	.	0	23255	7271.5	1	7702.4
11	110.79	18.8343	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	76666	23590.1	1	.
12	111.69	4.7803	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	32148	9544.0	1	17935.8
13	89.23	4.3009	1	.	.	0	3271.46	878.71	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	20708.9
14	129.81	13.6560	1	.	.	0	9976.59	2415.33	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	10997.3
15	186.07	3.4795	1	.	.	0	4544.10	776.59	1	.	.	2	.	.	0	.	.	0	.	.	0	26172	6521.2	1	13631.2
16	9.58	0.7942	1	0.0965	0.013452	1	1208.27	138.47	1	.	.	2	.	.	0	.	.	0	.	.	0	0	0.0	1	17103.7
17	26.29	2.2268	1	.	.	0	2432.52	427.15	1	.	.	2	.	.	0	.	.	0	.	.	0	6242	1587.2	1	16126.8
18	65.81	3.9693	1	.	.	0	4555.16	832.68	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	12346.2
19	333.83	3.7055	1	0.8760	0.068958	1	2628.90	600.70	1	.	.	2	.	.	0	.	.	0	.	.	0	17122	4164.7	1	9090.4

OBS	ENA	NACODE	CVA	EVA	VACODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACODE	DATE	SUBAREA	TEXTURE
1	267.97	1	102.72	7.036	1	47194.5	1463.0	1	443.4	9.843	1	.	.	0	.	.	0	82	1	GRAB
2	.	0	729.56	106.078	1	45682.4	10050.1	1	32007.8	368.090	1	.	.	0	.	.	0	82	1	FINES
3	.	0	.	.	0	.	.	0	31375.6	366.563	1	.	.	0	82534.1	20217.5	1	82	1	FINES
4		2		.	2		.	2			2			2	.	.	2	82	3	MIXED
5	732.68	1	443.65	34.871	1	41849.2	3159.6	1	15549.8	113.514	1			3	51423.0	6937.7	1	82	3	MIXED
6	612.58	1	213.34	28.972	1	51110.3	2729.13	1	8460.6	82.068	1			0	70939.9	5371.2	1	82	2	ORGANIC
7	277.10	1	61.91	6.934	1	66233.8	1026.6	1	1024.9	14.758	1	420.88	94.696	1	11640.0	1567.9	1	82	2	SOIL
8	833.86	1	352.40	34.218	1	27955.7	3233.7	1	13489.2	139.263	1			0	48169.8	6840.1	1	82	4	GRAB
9	808.16	1	305.97	51.219	1	41246.9	6649.0	1	12994.1	106.551	1		.	0	33654.1	6202.5	1	82	4	GRAB
10	920.44	1		.	0	39237.8	5226.5	1	22701.8	138.481	1			0	56260.1	8495.3	1	82	1	FINES
11	.	0			0		.	0	24971.3	317.135	1			0	46748.5	15660.7	1	82	1	CLAY
12	975.71	1		.	0	41843.5	7289.1	1	17238.9	134.463	1			0	43859.4	9015.2	1	82	2	GRAB
13	911.19	1		.	0	42552.2	5212.6	1	19920.9	125.502	1			3	39231.6	6583.6	1	82	2	GRAB
14	1810.16	1	403.85	73.743	1	37622.1	7370.2	1	18200.3	265.725	1			0	37207.4	13725.8	1	82	3	GRAB
15	894.21	1	246.07	35.237	1	50152.4	3515.7	1	15283.3	119.210	1			0	30274.0	6169.8	1	82	4	GRAB
16	234.32	1	95.23	7.685	1	60300.2	1610.0	1	690.6	12.155	1			0	11400.0	1598.3	1	82	1	GRAB
17	595.08	1	118.52	19.141	1	53889.7	2193.3	1	3887.9	57.153	1			0	12903.4	3362.6	1	82	1	GRAB
18	827.33	1	146.40	36.673	1	34274.6	4178.1	1	17576.9	119.537	1			0	19914.3	5163.8	1	82	2	GRAB
19	643.60	1	370.80	27.773	1	52770.6	2649.1	1	9574.7	87.130	1			0	19754.5	4953.4	1	82	3	FINES

OBS	SUBLOC	DCO2	OU	DOY	DBA	DTI	DSR	DI	DBR	DMG	DNA	CVA	n4L	OMN	OCL	OCA
1	SHAFT CNTL SOIL	13.43	.		.	.	698.0	1.594	52.59		.	.	.	.	357.45	3624.0
2	GARBAGE LAKE	260.61	.	12.730	9860.9	.	21102.4	41.092	175.55		8362.97	.	.	.	2437.77	26324.1
3	GARBAGE LAKE	320.36	.	12.760	9833.8	.	20870.5	44.745	195.43		8338.88	616.10	86560.5	.	2470.60	
4	GARBAGE LAKE	.	.	.	.	.				.		.	.	.	.	
5	GARBAGE LAKE	.	.		3069.2	.	6504.2	12.722	47.65	.		.	.	.	926.51	
6	GARBAGE LAKE	.	.	2.570	.	.	4427.5	8.335	35.20	.		.	.	.	793.82	
7	GARBAGE LAKE	.	.	.	.	.	934.6	1.802	7.29			.	.	.	.	
8	GARBAGE LAKE	54.78	.	2.740	2248.2	.	6466.3	12.700	55.91			.	.	.	948.08	
9	GARBAGE LAKE	.	.	2.630	2103.8	.	6326.0	13.079	59.47			.	.	.	778.17	
10	COBALT CHANNEL	75.95			.	.	7294.2	16.005	614.76			321.74	.	.	1342.48	
11	COBALT CHANNEL	296.61	.	1.090	11494.0	.	17211.4	37.473	1315.83		6397.30	345.65	39072.7	.	2590.14	
12	COBALT CHANNEL	.	.	0.267	3044.0	.	69'42.3	15.928	618.78			190.97	.	.	1339.04	
13	COBALT CHANNEL	.	.	0.259	.	.	6667.7	14.753	562.15	30492.4		142.60	.	.	1314.64	
14	COBALT CHANNEL	242.10	.	0.952	.	.	15512.5	29.661	1052.55	71379.1		.	.	.	1773.73	
15	COBALT CHANNEL	.	.	0.255	.	.	6898.5	13.402	495.51			.	.	.	459.12	
16	BEAR RAY	.			.	.	776.6	1.792	65.11		.	.	.	.	330.29	
17	BEAR CPEEK	39.10	.	0.160	.	.	394n.7	6.680	242.84		.	.	.	.	638.61	
18	BEAR CPEEK	.	.	0.234	.	.	6310.0	13.599	520.60	27563.9		.	.	.	1125.87	
19	LABINE BAY	.	.		.	.	5085.8	9.966	370.39			.	.	.	714.87	

-A83-

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAREA	AMEND	SAMPTYPE	SAMPID	RNUM	PH	COND	MOIST	LOI	CRA	ERA	CPB210	EPB210	CPB	CNI	CCU	CCO	CCO2	ECO2	CCODE
20	R	05	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	1	7.4	220	.	10.5	.	.	.	.	.	.	.	.	58.45	3.910	1
21	R	05	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	2	7.4	220	.	10.6	.	.	.	.	.	.	.	.	37.49	3.547	1
				.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	7.5	80	.	0.8	.	.	.	.	.	.	.	.	41.77	5.328	1
23	R	05	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	1	7.2	150	.	3.9	.	.	.	.	.	.	.	.	223.83	7.437	1
24	R	05	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	2	7.2	150	.	2.0	.	.	.	.	.	.	.	.	63.20	5.665	1
25	R	05	N	.	.	.	NO AMENDMENT	SEDIMENT	LAKE SEDIMENTS	.	7.9	120	.	2.4	.	.	.	.	.	.	.	.	.	.	0
26	R	06	N	.	.	.	NO AMENDMENT	SEDIMENT	SURFACE	.	8.5	180	.	0.4	.	.	.	.	.	.	.	.	2075.72	7.866	1
27	R	06	N	.	.	.	NO AMENDMENT	SEDIMENT	SURFACE	.	7.4	140	.	0.3	.	.	.	.	.	.	.	.	794.36	6.356	1
28	R	08	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.4	850	0.1	1.1	.	.	.	.	.	.	.	.	128.81	24.409	1
29	R	08	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.4	300	0.2	1.5	.	.	.	.	.	.	.	.	2150.88	328.009	1
30	R	08	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.2	240	0.2	2.3	.	.	.	.	.	.	.	.	.	.	0
31	R	08	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.4	290	0.1	1.7	.	.	.	.	.	.	.	.	166.14	19.787	1
32	R	08	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.2	600	0.1	1.0	.	.	.	.	.	.	.	.	70.89	15.497	1
33	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	4.3	1700	1.0	5.5	.	.	.	.	.	.	.	.	.	.	0
34	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	3.5	2800	0.8	2.0	.	.	.	.	.	.	.	.	50.42	4.694	1
35	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	3.1	4000	0.0	4.8	.	.	.	.	.	.	.	.	618.79	12.066	1
36	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	2.9	5800	0.8	2.0	.	.	.	.	.	.	.	.	.	.	.
37	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	3.2	9800	0.7	2.2	.	.	.	.	.	.	.	.	73.94	6.337	1
38	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	3.3	10000	0.9	5.1	.	.	.	.	.	.	.	.	91.45	4.947	1

OBS	CU	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE
20	47.78	0.8027	1	0.1580	0.018375	1	1114.4	126.15	1	.	.	2	.	.	0	.	.	0	.	.	0	5970.5	478.6	1
21	34.23	0.7325	1	0.1350	0.017199	1	1046.1	119.67	1	.	.	2	.	.	0	15.95	4.52501	1	.	.	0	3587.3	2461.1	1
22	51.67	1.0799	1		0.016233	1	1213.6	170.15	1	.	.	2	.	.	0	.	.	0	.	.	0	0.0	0.0	1
23	270.45	1.5957	1	0.1980	0.019127	1	1349.3	196.06	1	.	.	2	.	.	0	.	.	0	.	.	0	5402.9	627.9	1
24	80.49	1.0933	1	0.1740	0.020428	1	1195.9	160.62	1	.	.	2	.	.	0	.	.	0	.	.	0	4658.2	501.5	1
25	747.20	5.9029	1	0.3520	0.088774	1	3982.1	1014.23	1	.	.	2	.	.	0	.	.	0	.	.	0	26756.9	7560.7	1
26	478.92	1.8199	1	5.2100	0.225072	1	1099.1	162.88	1	.	.	2	.	.	0	.	.	0	.	.	0	36125.1	1770.4	1
27	163.93	1.3114	1	2.3300	0.170556	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	17115.1	1208.8	1
28	67.10	4.6567	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0
29	24.55	4.3846	1	3.4300	0.770721	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	38132.5	10410.2	1
30	74.67	15.8450	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0
31	63.38	3.8282	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0
32	121.78	3.1297	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	27912.9	5432.2	1
33	555.52	3.6109	1	4.2800	0.585504	1	2235.4	370.01	1	.	.	2	.	.	0	.	.	0	.	.	0	16990.9	2681.6	1
34	207.95	1.2061	1	4.1400	0.176364	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	28726.0	1491.1	1
35	2382.48	3.5737	1		0.333670	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	36860.2	1856.2	1
36	0.00	.	.	[illegible]	.	.	0.0	.	.	0.02	.	.	.	.	.	.	.	.	.	.	.	.	.	.
37	356.27	1.5320	1	4.5500	0.190190	1	840.6	131.55	1	.	.	2	.	.	0	.	.	0	.	.	0	27631.6	1348.3	1
38	276.32	1.3540	1	4.4400	0.187368	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	8879.6	880.0	1

OBS	CNA	ENA	NACODE	CVA	EVA	VACODE	CAL	L	AE	N	EMN	MODE	CCL	ECL	CLCODE	CCA	FC4	C4CODE	DATE	SUBAREA
20	12022.7	215.21	1	109.36	5.8398	1	63953.3	972.09	1	502.9	10.011	1	240.80	69.374	1	7764	1216.7	1	82	I
21	11723.7	203.99	I	95.33	5.4147	1	60516.5	907.75	I	674.3	9.960	1		.	0	6916	1249.5	1	82	I
22	18150.1	255.92	1	96.64	8.8136	1	67954.6	1746.43	1	1064.5	15.222	1	343.83	103.287	1	10959	1690.9	I	82	
23	12247.3	222.90	1	179.05	10.6177	1	49531.2	1674.16	1	2135.4	[illegible]	1		.	0	13745		1	82	
24	16062.7	240.94	I	96.14	6.0857	1	51493.0	906.28	1	1088.3	15.026	I		.	0	10361	4035.6	1	82	
25	6263.5	943.79	1	263.58	41.7247	1	40108.6	4271.84	I	21037.4	140.951	1		.	0	24462		I	82	4
26	1924.4	123.54	1	428.45	8.0977	1	44853.1	733.49	1	720.1	11.610	1	304.59	57.012	1	16729	1651.9	I	82	1
27	2087.4	121.49	1	355.98	9.5759	1	40713.2	1144.04	1	927.1	13.350	1	347.37	64.955	1	12625	1535.7	1	82	
29	12616.5	928.58	1	195.30	57.1448	1	30160.1	7727.02	1	21341.4	134.451	1		.	0	54117	8556.0	1	82	2
29	12086.0	861.73	1	337.57	54.4838	I			0	18596.6	126.457	1		.	0	49019	7431.9	I	82	1
3c	13773.0	2045.29	1	.		0	51029.1	8577.99	1	23484.1	307.642	1		.	0	42510	14241.0	I	82	1
31	15549.8	1048.06	1	206.18	38.4938	1	52456.8	3902.79	1	19900.4	131.343	1		.	0	56132	7274.7	1	82	7
32	17957.5	854.78	1	14.11	29.1551	1	47463.3	3089.86	1	11736.3	98.562	1		.	0	43771	6377.5	1	82	[illegible]
33	3894.7	343.90	1	548.75	21.6207	I	60212.7	2029.17	1	1576.5	35.872	I		.	0	13517	3557.8	1	82	[illegible]
34	2423.1	117.62	1	343.04	7.5812	1	37004.4	799.30	1	274.1	7.402	1	161.55	52.762	1	13478	1502.8	1	82	1
35	3791.9	201.35	1	570.37	10.2096	1	62630.6	1027.14	1	1779.5	18.506	1		.	0	12905	1504.3	1	82	[illegible]
36	1994.8	135.45	1	381.53	8.9278	I	50131.0	947.48	1	251.9	8.815	1		.				.	82	[illegible]
37	2204.4	115.07	1	407.89	7.5460	1	51260.3	789.41	1	350.3	8.162	1	273.06	49.042	1	21015	1746.3	1	82	4
38	1372.5	106.65	1	155.34	5.2971	I	20900.8	563.50	1	311.6	7.916	1		.	9	137207	4459.2	1	82	5

OBS	TEXTURE	SUBLOC	DCO2	DU	DOY	DOA	DTI	DSR	DI	D8R	DMG	DNA	DV4	DaL	DMN	3CL	DC
20	GITZ	LABINE CAY			.			772.8	1.527	52.37							
21	GITZ	LABINE BAY		.	.		.	737.4		50.84					.	195.70	.
22	CLAY	LABINE CAY			.	.		970.3	2.192	e2.22							
23	GRAB	LAOINE BAY	.	.	.	.	.	1203.1	2.757	153.37					.	333.14	.
24	GRAH	LABINE BAY		.	.	.	.	1021.5	2.014	71.15					.	229.77	.
25	GRAH	LABINE DAY	82.50			.	.	7510.9	16.253	610.92					.	1201.33	.
26	GRAB	MURPHY DAY		.	.		.	998.0	19.040	63.05		.					
27	GRAB	MURPHY BAY	.	.	.	544.18	.	895.5	20.300	71.39							
28	COAPSE	SILVER POINT		.	2.65	3094.31	.	7079.9	16.173	62.73	35417.9				.	1370.73	.
29	FINES	SILVER POINT			.	2920.93	.	6647.1	15.105	58.64				22825.9	.	1286.31	.
30	COARSE	SILVER PUINT	282.98	.	11.34	9217.41	.	17476.7	33.774	124.12	80086.7	.	278.00		.	1578.55	.
31	COARSE	SILVEP POINT			3.17	2614.98	.	1703.2	14.944	66.48	329C3.1				.	1096.42	.
32	FINES	SILVER POINT	.		2-45	2000.2H	.	5797.3	11.294	50.07					.	997.77	.
33	COAUSE	WEST AUDIT	40.86				.	2512.8	4.649	16.42					.	443.56	.
34	GRAB	WEST AUDIT				360.49		708.8	1.348	5.16							
35	GRAH	WEST AUDIT		.		2701.54	.	1482.0	2.802	11.49					.	255.97	.
36	GRAO	WEST AUDIT	.	.	.	.	.									.	
37	GRAB	UEST AUDIT		.	.	.	.	767.2	1.444	4.65							
38	GRAB	WEST AUDIT			.	354.16		667.6	1.290	5.02					.	187.96	.

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAREA	AMEND	SAMPTYPE	SAMPIO	RNUM	PH	COND	MOIST	LOI	CRA	ERA	CPB210	EPB210	CPB	CNI	CCU	CCO	CCON	ECO2	CO2CODE
39	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	3.5	3000	0.7	1.3	.	.	.	.	.	.	.	.	48.21	4.7053	1
40	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	6.2	700	11.3	17.0	.	.	.	.	.	.	.	.	149.24	0.9994	1
41	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.5	260	0.1	2.9	.	.	.	.	.	.	.	.	.	.	0
42	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	6.7	600	0.8	3.4	.	.	.	.	.	.	.	.	476.52	20.9669	1
43	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	5.5	2000	2.4	17.3	.	.	.	.	.	.	.	.	.	.	0
44	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	UNKNOWN	.	5.2	500	3.9	10.4	.	.	.	.	.	.	.	.	42.97	10.3644	1
45	R	09	N	.	.	.	NO AMENDMENT	BARE TAILINGS	UNKNOWN	.	6.3	430	1.6	2.4	.	.	.	.	.	.	.	.	247.48	16.2594	1
46	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	6.9	360	0.1	3.4	.	.	.	.	.	.	.	.	311.93	.	.
47	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.6	000	3.8	1.6	.	.	.	.	.	.	.	.	74.37	5.4357	1
48	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.5	840	0.4	3.5	.	.	.	.	.	.	.	.	259.63	26.0928	1
49	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	8.5	14000	0.9	6.1	.	.	.	.	.	.	.	.	.	.	0
50	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.7	530	0.4	3.8	.	.	.	.	.	.	.	.	.	.	0
51	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	6.5	160	4.5	0.9	.	.	.	.	.	.	.	.	11.30	0.1687	1
52	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.7	250	0.1	1.9	.	.	.	.	.	.	.	.	.	.	0
53	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	3.2	1000	4.0	11.8	.	.	.	.	.	.	.	.	25.02	3.5804	1
54	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	5.3	1300	0.3	2.7	.	.	.	.	.	.	.	.	14.70	3.5500	1
55	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.7	290	0.2	3.0	.	.	.	.	.	.	.	.	384.35	21.9321	1
56	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.4	750	4.0	2.7	.	.	.	.	.	.	.	.	92.89	24.2536	1
57	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	6.9	820	0.2	4.3	.	.	.	.	.	.	.	.	419.95	.	.

OBS	CU	EU	UCODE	CCO	EDY	DYCODE	CBA	EBA	NQUOCW	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG	MGCODE	CNA	ENA	NACODE
39	295.33	1.3290	1	4.20	0.175968	1			0	.	.	2	.	.	0	.	.	0	.	.	0	29235.7	1286.36	1	1908.7	120.819	1
40	1882.27	3.1999	1	3.83	0.259463	1	1847.0	175.65	1	.	.	2	.	.	0	.	.	0	.	.	0	35087.8	1717.83	1	6198.9	188.448	1
41	112.64	15.3754	1	.	.	0	14858.3	2806.74	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0
42	1813.23	5.9837	1	4.91	0.764407	1	2722.8	497.19	1	.	.	2	.	.	0	.	.	0	.	.	0	43583.7	5388.98	1	3758.9	496.923	1
43	844.83	3.8862	1	7.82	0.508300	1	1302.0	307.52	1	.	.	2	.	.	0	.	.	0	.	.	0	26467.0	4099.74	1	4212.4	323.093	1
44	1923.37	3.4630	1	4.19	0.273607	1	1682.9	181.92	1	.	.	2	.	.	0	.	.	0	.	.	0	42041.1	1916.60	1	1523.4	153.405	1
45	1364.60	4.6396	1	6.31	0.501014	1	2060.7	351.36	1	.	.	2	.	.	0	.	.	0	.	.	0	36783.7	3643.92	1	2902.9	412.219	1
46	.	.	0	.	.	0	16443.9	3658.77	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0
47	156.35	1.2039	1	6.95	0.159842	1	537.4	124.41	1	.	.	2	.	.	0	.	.	0	.	.	0	9727.0	767.17	1	3082.3	117.125	1
48	129.22	13.5681	1	.	.	0	13063.6	3000.70	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0
49	127.50	14.5477	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0
50	108.38	16.6472	1	.	.	0	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0
51	56.47	0.3075	1	2.73	0.171990	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	28407.0	1388.49	1	2208.5	126.768	1
52	88.85	13.6740	1	.	.	0	12755.3	3221.99	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0
53	78.88	0.9071	1	3.49	0.181820	1	720.2	104.43	1	.	.	2	.	.	0	.	.	0	.	.	0	26157.9	1340.91	1	1681.5	109.289	1
54	66.77	0.9014	1	4.50	0.189450	1	666.4	103.55	1	.	.	2	.	.	0	.	.	0	.	.	0	19114.1	1212.58	1	1767.6	110.831	1
55	71.95	3.9213	1	2.30	0.682870	1	.	.	0	.	.	2	.	.	0	.	.	0	.	.	0	30236.4	8565.92	1	4181.9	726.816	1
56	99.01	5.0297	1	.	.	0	4020.1	1054.64	1	.	.	2	.	.	0	.	.	0	.	.	0	26356.1	8961.73	1	7216.3	991.526	1
57	.	.	0	.	.	0	17064.3	4255.83	1	.	.	2	.	.	0	.	.	0	.	.	0	.	.	0	.	.	0

OBS	CVA	EVA	VACOVE	CAL	EAL	ALCCCE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA	ECA	CACOCE	DATE	SUB4REA	TFXTURE
39	428.21	7.5365	1	52731.0	785.69	1	276.9	7.172	1	264.15	51.000	1	17543.3	1532.1	1	82	5	GRAil
40	491.66	8.9027	1	55998.4	9c7.17	1	690.3	11.666	1			0	19575.7	1712.8	I	82	6	GRAB
41			0	42557.0	8166.69	1	25723.4	303.680	1			9	47519.2	14526.6	1	87	1	COARSE
42	559.99	27.8875	1	65014.8	2503.07	1	4946.1	64.794	I			0	39822.3	6100.8	1	92	9	FINES
43	118.39	13.3307	1	.	.	0	1545.6	34.621	1			0	12397.0	3790.6	1	82	8	ORGANIC
44	747.11	10.7554	1	61831.3	S70.75	1	481.9	10.553	I	297.17	83.327	1	14138.3	1560.9	1	82	7	COARSE
45	636.48	21.8949	1	73364.1	2156.90	1	1870.9	37.791	1			0	19750.4	4163.4	1	92	7	FINES
46			0		.	0	37585.0	398.401	1			0	63127.?	16703.6	1	82	5	COARSE
47	390.75	10.5833	1	50109.2	1508.29	1	344.0	8.393	1	420.71	65.252	1	8658.9	906.6	1	82	2	FINES
48	455.35	96.0788	1	33170.0	8723.71	1	30291.I	339.260	1			0	56553.1	15993.2	1	82	6	FINES
49	284.90	83.6361	1	32713.3	7766.26	1	20714.3	287.929	1	2562.73	€31.200	1	41391.1	13220.3	1	82	3	GRAG
50	587.42	95.8082	1	35030.3	8603.05	1	24047.9	327.052	1			0		.	0	82	A	GRAB
51	452.87	8.0158	1	43309.3	763.65	1	535.0	0.951	1	449.74	58.016	1	12201.7	1300.7	1	82	7	GRAB
52	357.41	8.7923	1	3139t.4	8659.12	1	25865.9	333.670	1			0	48382.1	17791.4	1	82	2	COARSE
53	440.93	8.2013	1	47350.5	786.02	1	388.4	0.022	1	231.88	46.909	1	22733.0			82	4	COARSE
54	398.22	8.0042	1	37946.1	736.15	1	323.4	8.343	1	212.93	53.232	1	€8724.8	3223.2	1	82	4	COARSE
55	233.80	43.2998	1	29793.0	5368.70	1	15047.6	109.847	1			0		.	0	82	1	FINES
56	274.71	47.8270	1	30914.3	4971.02	1	26381.0	153.010	1			0	49643.8	7590.5	1	82	3	FINES
51	.	.	0	.	.	0	38336.6	410.201	1		.	0			0	a2	5	FINES

OBS	SUBLOC	DCO2	DU	DDY	n.BA	DTI	DSR	DI	OBR	OMG	ONA	DVA	OA1	DMN	DCL	DCA
39	WEST AUDIT	.	.		361.76	.	711.4	1.336	5.20							.
40	WEST AUDIT	.	.	.		.	1114.3	2.105	8.03						227.43	
41	WEST AUDIT	276.07	.	11.05			17633.3	343.960	1231.11	83236	6211.20	289.95			2055.46	
42	WEST AUVIT		.	.	.		3851.5	71.560	200.57						683.55	
43	WEST AUDIT	41.79	.	.		.	2170.5	4.026	15.62				3121		511.87	
44	WEST AUDIT		.	.	.	.	1147.3	2.133	7.87						.	
45	WEST AUDIT	.	.			.	2819.1	5.314	21.80		.				643.56	
46	MURPHY LAKE	.	72.28	18.81		.	21447.4	398.270	1604.52	98409	7968.40	399.89	33463		2594.99	
47	MURPHY LAKE						€65.6	15.130	50.52						.	
4M	MURPHY LAKE	.	.	10.39	.		19056.I	372.480	1348.05	85512	7214.65				2079.29	
49	MURPHY LAKE	258.69	.	10.20	8517.61	.	16584.9	317.980	1148.31	74250	5836.29				.	
50	MURPHY LAKE	298.97	.	11.32	9818.81	.	18296.I	361.550	1321.00	85480	6650.04				2461.75	63068.3
51	MURPHY LAKE	o		.	369.42	.	768.8	15.190	62.85					.	.	
52	MURPHY LAKE	274.57	.	10.91			17790.0	373.910	1322.25	76848	6701.03				2413.81	
53	MURPHY LAKE	.			.		645.5	12.440	48.18						.	
54	MURPHY LAKE	.	.	.	.	.	632.4	11.820	45.10						.	
55	MURPHY LAKE		.		2579.71	.	5912.7	130.610	503.19		.				1100.31	13050.0
56	MURPHY LAKE	.		2.98	.		8080.a	176.480	671.08						1336.57	
57	MURPHY LAKE	.	78.20	13.04			21420.8	501.350	1905.06	10499?	7882.36	667.38	103733		3457.26	57344.5

OBS	SITE	AREA	LOCALE	AGE	TAILWT	SURAREA	AMEND	SAMPTYPE	SAMPID	RNUM	OT	CONDO	MOIST	LOI	CRA	ERA	CPB210	EPB210	CPH	CNI	CCU	CCO	CCO2
58	R	10	N	.	.	.	NO AMENDMENT	BARE TAILINGS	20-25 CM DEEP	.	7.3	270	1.5	40.6	.	.	.	.	.	.	.	.	819.57
59	R	11	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.7	170	0.2	0.5	.	.	.	.	.	.	.	.	1097.79
60	R	11	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.4	220	0.1	1.0	.	.	.	.	.	.	.	.	2520.57
61	R	11	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.5	210	0.1	0.8	.	.	.	.	.	.	.	.	970.02
62	R	11	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.0	140	0.3	1.9	.	.	.	.	.	.	.	.	324.20
63	R	11	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.6	160	0.3	0.5	.	.	.	.	.	.	.	.	717.75
64	R	12	N	.	.	.	NO AMENDMENT	OVERBURDEN	SURFACE	.	8.0	500	0.2	2.0	.	.	.	.	.	.	.	.	.
65	R	12	N	.	.	.	NO AMENDMENT	PROCESS SLIMES	SURFACE	.	7.2	480	.	4.9	.	.	.	.	.	.	.	.	149.35
66	R	13	N	.	.	.	NO AMENDMENT	BARE TAILINGS	SURFACE	.	7.9	230	0.6	2.1	.	.	.	.	.	.	.	.	.

OBS	ECO2	CO2CODE	CW	EU	UCODE	CDY	EDY	DYCODE	CBA	EBA	BACODE	CTI	ETI	TICODE	CSR	ESR	SRCODE	CI	EI	ICODE	CBR	EBR	BRCODE	CMG	EMG
58	1.80305	1	1195.52	2.63014	1	1.670	0.236639	1	1552.93	184.177	1	.	.	2	.	.	0	.	.	0	.	.	0	30328.6	1914.07
59	2.19478	1	1476.61	2.95322	1	3.960	0.213840	1	1879.16	205.204	1	.	.	2	.	.	0	.	.	0	.	.	0	34153.6	2230.42
60	4.05314	1	1457.04	2.91408	1	4.030	0.218426	1	1792.23	208.436	1	.	.	2	.	.	0	.	.	0	.	.	0	32524.3	1667.24
61	4.07408	1	1000.67	4.20281	1	3.930	0.482211	1	1550.53	385.152	1	.	.	2	.	.	0	.	.	0	.	.	0	53553.4	4655.74
62	3.13196	1	1240.61	4.71432	1	4.530	0.485163	1	2386.32	384.755	1	.	.	2	.	.	0	.	.	0	.	.	0	44279.8	4533.19
63	2.94277	1	1095.14	4.49007	1	3.610	0.479769	1	2018.46	374.222	1	.	.	2	.	.	0	.	.	0	.	.	0	60313.5	5168.41
64	.	0	82.06	3.20034	1	.	.	0	2023.96	599.902	1	.	.	2	.	.	0	.	.	0	.	.	0	16427.4	4097.71
65	5.34780	1	69.65	1.02385	1	1.360	0.239360	1	1193.07	175.262	1	.	.	2	.	.	0	.	.	0	.	.	0	16630.9	1272.33
66	.	0	21.47	2.37888	1	0.179	0.052823	1	2879.04	470.147	1	.	.	2	.	.	0	.	.	0	.	.	0	7308.2	1691.44

PORT RADIUM DATA DUMP OF 1982 TAILING SAMPLE DATA 12:03 WEDNESDAY, MARCH 7 1984

OBS	MGCODE	ZN4	ENA	NACODE	CVA	EVA	VACODE	CAL	EAL	ALCODE	CMN	EMN	MNCODE	CCL	ECL	CLCODE	CCA
58	1	997.2	133.223	1	231.06	7.2322	1	23104.6	681.59	1	1597.58	17.0513	1	201.74	61.0361	1	34141.9
59	1	2577.9	149.520	1	480.67	12.2090	1	41044.1	1502.21	1	1560.95	17.1704	1	.	.	0	26523.5
60	1	2890.8	154.370	1	538.07	11.0842	1	65353.1	1307.06	1	1406.09	16.4513	1	.	.	0	27553.6
61	1	1941.1	345.518	1	525.51	20.4423	1	53476.3	1914.45	1	2284.46	42.0341	1	.	.	0	33237.5
62	1	3054.0	359.451	1	496.49	20.1575	1	50499.5	1388.68	1	1942.45	39.2375	1	.	.	0	24734.2
63	1	2391.5	337.435	1	467.47	19.8207	1	50644.4	1894.10	1	1667.23	36.6791	1	.	.	0	37641.5
64	1	13608.9	722.634	1	.	.	0	49753.6	2801.13	1	8234.96	88.1141	1	.	.	0	15249.6
65	1	16673.5	255.105	1	162.24	7.3819	1	51756.8	936.80	1	1620.09	17.8210	1	.	.	0	8920.3
66	1	17069.5	631.573	1	76.31	20.7945	1	56558.6	2409.40	1	5069.30	65.3940	1	.	.	0	13706.3

OBS	ECA	CACODE	DATE	SUBAREA	TEXTURE	SUBLOC	DCO2	DU	DDY	DEa	DTI	DSR	DI	DBP	DMG	DNA	DVA	DAL	DMN	DCL	DCA
58	2198.74	1	82	6	ORGANIC	MURPHY LAKE	.	.	.	.	.	1199.00	23.930	63.10	.	.	.	.	.	.	.
59	2299.59	1	82	3	COARSE	MURPHY CREEK	.	.	.	.	.	1173.46	26.630	95.34	.	.	.	.	.	25.75	.
60	2201.54	1	82	1	MIXED	MURPHY CREEK	.	.	.	.	.	1178.39	25.810	88.94	.	.	.	.	.	270.60	.
61	5171.75	1	82	2	MIXED	MURPHY CREEK	.	.	.	.	.	2918.71	56.900	192.35	.	.	.	.	.	400.08	.
62	4493.38	1	82	2	MIXED	MURPHY CREEK	.	.	.	.	.	2813.05	56.240	185.65	.	.	.	.	.	528.50	.
63	5431.67	1	82	4	MIXED	MURPHY CREEK	.	.	.	.	.	2663.69	53.530	172.37	.	.	.	.	.	460.88	.
64	4170.82	1	82	2	COARSE	PARKING LOT.	55.50	.	Z.26	.	.	5146.64	99.920	372.34	.	.	82.34	.	.	777.91	.
65	1247.06	1	82	1	GRAB	PARKING LOT	.	.	.	.	.	1176.61	23.310	85.93	.	.	.	.	.	185.73	.
66	3884.52	1	82	1	GRAB	GARBAGE CREEK	41.90	.	.	.	.	3820.37	7.474	280.04	.	.	.	.	.	655.55	.

Appendix B: Analytical Methods

Introduction: The sections in this report have originated from several sources. Since in many instances, concentrations of heavy metals and radionuclides are at or below the detection limit, reporting of the various analytical methods used was considered essential.

The methods, analytical procedures and related information are reported, as supplied to M. Kalin, University of Toronto, with no intended changes.

The views expressed and the statements made remain the responsibility of the named author(s).

M. Kalin, March 20, 1984

APPENDIX B

DETAILED FIELD AND ANALYTICAL METHODS

Table of Contents

LIST OF TABLES

APPENDIX B - RADIONUCLIDE ANALYSIS

1.1 Chemex Laboratory

Radium-226: Radium-226 measurements were performed using a Canberra Model 2200 Alpha-Beta Analyzer, described previously. A certified Ra-226 solution was purchased from Amersham Radiochemicals. This solution had been previous calibrated against a US National Bureau of Standards Ra-226 source and had a total uncertainty of not greater than ± 39 percent in its activity.

Radium-226 was determined by the precipitation method in which radium is isolated by a radiochemical separation involving coprecipitation with barium sulfate. The radium barium sulfate precipitate is stored for a week to allow for the ingrowth of radon and its daughters, thereby increasing the sensitivity of the method. The precipitate is then alpha -- counted and compared with standards carried through the same pro ———

Experimental: Samples for total radium-226 were acidified to one percent HNO_3 at the time of collection and subsequently digested with perchloric add. Samples for dissolved radium-226 were filtered through a 3.0 micron membrane filter and then acidified to one percent HNO_3. Following digestion or filtration, radium is removed from solution by co-precipitation with lead sulfate. The lead sulfate is then dissolved in alkaline ethylenediaminetetraacetic add, barium carrier is added and barium sulfate preferentially precipitated by lowering the pH to 4.5. Radium is coprecipitated with the barium sulfate, redissolved and reprecipitated to remove traces of other radionuclides. The precipitate is transferred to a tared stainless steel planchet, dried under an infrared lamp and then in an oven, cooled in a desiccator and weighed. Samples are stored for a minimum of one week to allow for the ingrowth of radium-226 daughters and to allow for the decay of radium-223 and its daughters. At the end of this period, samples are counted for their alpha activity and compared to the activities of standard radium-226 solutions which have been carried through the same procedure. The detection limit of this method is 0.2 pCi/l at the 95 percent confidence level for a 100 minute counting period.

REFERENCE: APHA Sec. 705, pp. 661-666.

Lead-210: Lead-210 measurements were performed using a Canberra Model 220 Alpha-Beta Analyzer described previously. A standard lead-210 solution, obtained from Amersham Radiochemical Limited was certified to have a total uncertainty in its activity of not greater than ± 2.3 percent.

Lead-210 is difficult to determine directly because of the low energy of its beta emission. For this reason, lead-210 is determined indirectly by the measurement of the beta emission from its daughter, Bi-210. In this method, the bismuth-210 resulting from a definite ingrowth period or known to be in equilibrium with led-210 is isolated by solvent extraction and then precipitated as bismuth oxychloride for beta counting.

Experimental: Samples for total Pb-210 were acidified to one percent HNO_3 at the time of collection and subsequently digested with perchloric acid. Samples for dissolved Pb-210 were filtered through a 3.0 micron membrane filter and then acidified to one percent HNO_3.

Following digestion or filtration, a lead and bismuth carrier solution is added and the resulting solution is acidified to 2M HCL. Samples are then stored for 30 days to ensure that Pb-210 and Bi-210 are in equilibrium. Subsequently bismuth-210 is extracted into chloroform with diethylammonium diethyldithiocarbamate. An aliquot is removed in order to test the efficiency of the extraction by atomic absorption methods. The remaining bismuth is precipitated as mixed salts (hydroxide, oxychloride), separated and redissolved and finally precipitated as pure bismuth oxychloride. This precipitate is collected on a 0.45 micron membrane filter, air-dried, weighed and mounted on a ring and disc assembly, covered with aluminum foil and beta - counted after 24 hours. The aluminum foil serves to prevent the [redacted]ion of any weak Pb-210 beta particles while permitting the more energetic Bi-210 particles to pass through. The storage period of 24 hours allows for the decay of bismuth-211, bismuth-212 and bismuth-214. The activity of samples is compared with the activity of standards carried through the same procedure. Counting periods were of 100 minutes duration and the detection limit routinely achieved was 1 pCi/l at the 95 percent confidence level.

REFERENCE G. Smithson*, Saskatchewan Research Council, Method to be published in a Radionuclide Methodology Handbook by CANMET, EM & R.

Thorium Isotopes: The measurement of thorium isotopes 232, 230, 228 and 227 was performed at the Saskatchewan Research Council. Thorium isotopes were isolated from solution by electroplating onto stainless steel discs which were subsequently counted using alpha spectroscopy techniques Standard solutions of Th-232 and Th-228 were prepared from thorium

*based on H.G. Petrov and A. Cover, Anal. Chem., 37:1659, 1965.

nitrate purchased from Amersham Radiochemicals. The thorium nitrate was sufficiently aged to ensure that both isotopes were in secular equilibrium Solutions of known activity of Th-230 and Th-227 were prepared from uranium ores certified to be in secular equilibrium.

Experimental: Samples for total thorium isotopes were acidified to one percent HNO_3 at the time of collection. Prior to analysis, samples were spiked with lanthanum carrier as well as a known activity of a tracer, the beta-emitter Th-234, in order to measure the overall efficiency of the procedure. Samples were then digested with perchloric acid to ensure complete dissolution of all thorium species Thorium is then isolated from solution by coprecipitation with lanthanum hydroxide; purification is effected by redissolving this precipitate and precipitating lanthanum fluoride. The lanthanum flouride precipitate is then redissolved and the thorium isotopes are extracted into benzene using thenoyltrifluoroacetone, subsequently stripped into aqueous nitric acid and digested with perchloric arid to dryness. The residue is dissolved in water, an electrolyte (Na_2SO_4) is added and the [redacted] is transferred to a plating cell comparising a stainless steel disc cathode and a platinum anode. Electro-plating is carried out for three hours at 0.5 amperes of current after which time the stainless steel disc is rinsed with water and ethanol and dried at 150 °C.

The disc is then beta-counted for Th-234 in order to determine the overall recovery efficiency. The disc is then placed in a vacuum chamber, the chamber is evacuated and the thorium alpha spectrum is measured using a pure silicon ruggedized surface barrier detector with its associated preamplifier, amplifier and bias voltage supply. The spectrum is resolved into its constituent components by a Nuclear Data Model 100 multi-channel analyzer and the activity of samples is compared to the activity of standards carried through the same procedure. Counting periods were 100 minutes duration and the detection limits obtained were as follows: Th-232, Th-230, Th-228, all 0.3 pCi/l; Th-227, 0.5 pCi/l.

REFERENCE: G. Smithson, Saskatchewan Research Council, Method to be published in a Radionuclide Methodology Handbook by CANMET, EM & R.

15 CANMET, Radiochemical Procedures for Determination of Selected Members of the Uranium and Thorium Series, CANMET, Report 78-22, January 1979.

1.2 University of Waterloo

Radiochemistry for Radium-226 and Lead-210 Determinations (by H.D. Sharma)

Preparation of Materials. Radium adsorbs onto active sites in untreated glassware, resulting in effective radium loss. To prevent this, all glassware was coated with a silicon solution and then baked at high temperatures overnight to provide a firm coating.

Preparation of Cation Exchange Resin. Dowex 50W-X8 (200 - 400 mesh) resin in the H^-cation form was used. The resin was conditioned by allowing it to stand for 48 hours in a 3 N HCI solution. It was then de-aerated and 5.0 to 9.0 cm^3 of the resin was filled into a column (10 x 2 cm). The packed column was washed with de-ionized distilled water.

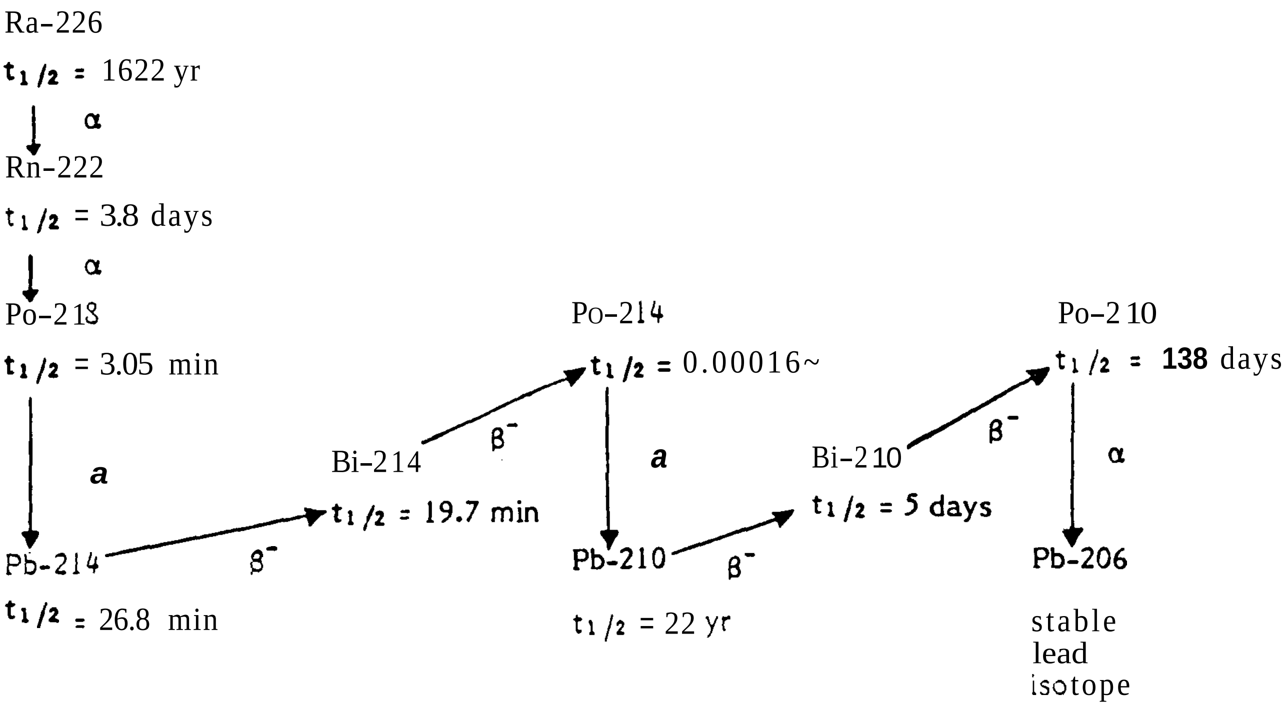
Sample Preparation. The samples were prepared at the Institute for Environmental Studies and supplied either as a solid or as a liquid sample. The liquid samples (water and vegetation digest) were adjusted to a pH range of 1.0 to 2.5. The solid samples (tailings and soils) were dried and each sample was placed in a Nalgene bottle with 30 mL of DTPA (Diethylenetriaminepentacetic acid). DTPA acts as an extracting agent bringing radium sulphate and other cations into the solution. The solution was centrifuged and acidified with HCl to pH 1-2.

Radioanalysis. The solution was passed through the cation exchange resin. The absorbed radium was eluted by passing 200 mL of 12 M HCI through the column. Six M HCI forms a constant boiling azeotrope, thus it can be prepared by boiling 12 M HCI down to approximately half volume. The resulting 6 M HCI solution was diluted to 3 M with distilled water and placed in a 125 mL Nalgene bottle.

Because of the sub-picogram yields of nuclear decay products, 1.0 μg of lead and 1.0 μg of bismuth inert carriers were added to the sample. Isotopic exchange between inactive and the radioactive isotopes was ensured. Further, 0.7 mL of a 2% solution of hydrazine dihydrochloride was added to ensure that the oxidation states of lead and bismuth were (II) and (III) respectively. Finally, a few drops of xylene were added to provide a covering for the solution to prevent escape of any radon gas.

The solution of the sample thus prepared was stored for a minimum of 3.8 days (the half-life of Rn = 3.8 days) to allow the growth of the daughter products.

The decay of radium-226 occurred to its daughter products during storage as shown in the following figure. The accuracy of the method depends on ensuring that no radon gas escapes during the storage period.



Lead and bismuth were extracted from the aqueous solution with 4.0 mL aliquots of DADDC (diethylammonium diethyldithiocarbamate) solution in xylene. This DADDC solution is prepared by mixing a solution of 5.0 mL of diethylamine in 45.0 mL of xylene with 10.0 mL of carbon disulphide in 40 mL of xylene. This procedure results in the extraction of the Pb-210, Pb-214, Bi-214 and Bi-210 into the organic layer. This organic layer is pipetted onto a stainless steel planchet and placed under a heat lamp. It is essential that the extraction is carried out within 20 minutes as the half-lives of Pb-214 and Bi-214 are short. The organic layer is evaporated, leaving lead and bismuth on the planchet.

The activities due to Bi-210, Bi-214 and Pb-214 were assayed with a gas flow proportional counter for beta activity for I hour subsequent to the extraction. The Pb-210 was not detected because of its low beta decay energy. The sample was counted again 1 day after the separation. The activities due to Bi-214 and Pb-214 had essentially decayed to negligible amount as their half-lives are 19.7 and 26.8 minutes respectively. By assuming that secular equilibrium exists between Pb-210 and Bi-210, the activity of Bi-210 is then equal to that of Pb-210. Thus the second assay minus background equals Pb-210 activity.

The assay results were then used by applying the standard decay equations for the determination of Ra-226 in the sample. An example of the calculation is given below:

Initial Pb-214 Activity

$$A_C = E_d \quad \frac{A_o e^{-\lambda_1 t_e}(1 - e^{-\lambda_1 t_c})}{\lambda_1} + \frac{\lambda_2 A_o\, e^{-\lambda_1 t_e}(1 - e^{\lambda_1 t_c})}{(\lambda_2 - \lambda_1)\,\lambda_1}$$

$$\frac{A_o\, e^{-\lambda_2 t_e}(1 - e^{-\lambda_2 t_c})}{\lambda_2 - \lambda_1} + \frac{A_o\, e^{-\lambda_2 t_e}(1 - e^{-\lambda_2 t_c})}{\lambda_2}$$

Where:

A_c - the number of counts due to Pb-214 and Bi-214 = (first count - background) - (second count - background)

A_o - initial activity of Pb-214 (at the time of the start of the extraction)

t_e - time of duration of extraction in minutes

t_c - duration of the counting period = 60 minutes

λ_1 - In $2/t_{1/2}$ in minutes for Pb-214

λ_2 - In $2/t_{1/2}$ in minutes for Bi-214

E_d - calibrated efficiency of the detector

This equation reduces to:

A_c = Ed $A_o f(t)$, where $f(t)$ is calculated for various values of t_e:

t_e = 13 min, $f(t)$ = 59.5176

t_e = 17 min, $f(t)$ = 55.6632

t_e = 18 min, $f(t)$ = 54.5862

t_e = 19 min, $f(t)$ = 53.5253

t_e = 20 min, $f(t)$ = 52.4517

The reduced equation is solved for A, and A, substituted into the equation A Ra-226 = $A_o/(1 - e^{-\lambda_3 t_s})$ where A Ra-226 = activity of radium-226 and $\lambda_3 = \ln 2/t_{1/2}$ in minutes of Rn-222 = 5472 min, t_s = storage time.

$$A\ \text{Pb-210} = \frac{(\text{number of second counts} - \text{background})}{2.2 \times E_d \times 60}$$

Error:

$$\text{Ra-226:}\quad \text{Error:}\quad \frac{(\text{net number of counts (first and second)} + \text{ave. background})^{1/2}}{60 \times 2.2 \times E_d \times \text{wt} \times (\text{in g or L})}$$

$$\text{Pb-210:}\quad \text{Error:}\quad \frac{(\text{number of second counts} + \text{background})^{1/2}}{60 \times 2.2 \times E_d \times \text{wt (in g or L)}}$$

Both results in ± pCi, 1 pCi = 1×10^{-12} Ci

Determination of radium standard activity. To determine the activity of the radium standard, alpha-ray spectroscopy was employed. A 0.2-mL sample of the standard was evaporated on a planchet. The planchet was placed in the alpha counter and counted overnight. The total number of counts under the appropriate peak were recorded.

$$\text{Activity} = \frac{\text{total counts} \times \text{geometry factor}}{\text{counting time (min} \times 2.22 \times 0.2\ \text{mL)}}$$

Geometry factors = 3.60

Using this procedure, the activity of the standard solution was determined. All analytical procedures were examined by using the standard solution.

1.3 Saskatchewan Research Council

(Letter from Gene Smithson to Ranjit Soniassy dated September 29, 1983, copy sent to M. Kalin from D. Sutherland).

Dear Mr. Soniassy:

The analytical methods used for determining uranium, radium-226 and lead-210 on your water and sediment samples were as follows:

Uranium: sediments were analyzed by delayed neutron counting using a Slowpoke II reactor for activation. This method has a detection limit of 0.1 ppm and a precision of ± 2 percent of the amount present. Water samples were first extracted with tri-octylphosphine oxide in cyclohexane to concentrate and isolate the uranium (Ashbrook, Energy, Mines and Resources Information Circular IC-226, 1971). The Uranium containing extract was then analyzed by the conventional ultra-violet excited fluorescence procedure after fusion with NaF (Ingles, Mines end Technical Surveys, Canada, Monograph 866, 1959).

Radium-226: water samples were analyzed by first concentrating the radium with lead sulfate, dissolving this solid in an alkaline-EDTA solution and then reprecipitating the radium with barium sulfate. The barium sulfate, after suitable preparation, is analyzed for radium by gross alpha counting (Smithson, Canmet Report 78-22, 1979, page 29). Sediment samples were analyzed by the same procedure after the solid had been dissolved using a potassium pyrosulfate fusion. The results for all solid samples were confirmed by determining the Ra-226 by gamma spectroscopy. The detection limit of the barium sulfate -- gross alpha counting procedure is 0.004 Bq/g (solids) or Bq/l (liquids). The one sigma standard deviation is approximately ± 7 percent of the amount present

Lead-210: water samples are analyzed by extracting bismuth-210 (daughter of lead-210) from the strongly acidified sample into a chloroform solution of diammonium diethyldithiocarbamate. The bismuth is back-extracted into an acidic aqueous phase and then precipitated as bismuth oxychloride. The preciitate is collected on a suitable planchet and the beta activity of bismuth-210 is measured on a low background, gas-flow, proportional counter (Smithson, Fahri and Petrow, Canmet Report 78-22, 1979, page 55). Sediment samples were analyzed in the same manner after they were dissolved by a potassium pyrosulfate fusion All sediment results were cross-checked by gamma spectroscopy of the solid sample using a planar germanium detector. The detection limit of the. beta counting procedure is 0.04 Bq/g (solids) or Bq/l (liquids). The one sigma standard deviation is approximately ± 5 percent of the amount present.

Request for confirmation of selected samples by M. Kalin to SRC.

(Letter from Gene Smithson to Margarete Kalin dated January 23, 1984).

Dear Margarete:

Sorry for the long delay in getting back to you I was trying to locate the samples here in the lab but was unsuccessful. The solids were returned to Ranjit and the remainder of the water samples was discarded back in October.

I went through the results and checked calculations and did not come up with any changes. The sediment and solid samples were analyzed by both gamma spectroscopy and the wet chemical procedure (radium-226 and led-210). Good agreement was obtained for the two methodologies so this would tend to confirm the reported results. Since there was no water sample remaining it is impossible to check the majority of the samples. Radium was repeated on three samples right after they were first analyzed.

5518	Gamma Lake water	4.0	4.0	(repeat)
5536	Silver Point (pour water) total	3.0	2 0	(repeat)
5545	P4 - surface sediment	35	36	(repeat)

A large amount of solids was present in 5536. This probably accounts for the large difference in the two results. It is difficult to reproducibly sample water containing large amounts of rapidly settleable solids That's about all the information I can provide you with on those samples.

NOTE: Confirmation was requested for the high radionuclide concentrations reported for Rayrock.

Dear Gene:

I have enclosed a listing of the results, all those available on the Rayrock and Port Radium study. There are some points I would like your opinion on, since I am not really sure what to make of i

In sorting the results according to type, such as water and tailings with respect to their locations, I cannot miss to note unusual similarities in the concentrations reported. I am extremely puzzled about the fad that out of 19 solid samples of SRC analysis, six samples have identical concentrations for Ra-226 and Pb-210. This would suggest a nearly perfect linear relationship of the two isotopes which in add tailings which have been on the surface for about 25 years is highly unlikely and from my previous results was never indicated.

Furthermore I note that the frequency with which the same concentrations a m reported is high, particularly in the higher concentration ranges (811 and 676) and in the water samples. I just don't know what to make of it, as the probability that identical concentrations exist in different environmental samples from my experience on the tailings is generally very low.

Given your errors and the detection limits which differ for Ra-226 and Pb-210 to produce identical numbers, even in replicate analysis appears to me difficult. Furthermore, I would like to report the concentrations reflecting the analytical precision, i.e. get decimal points or errors for all numbers.

I would be really pleased if you could comment on these queries as soon as possible. The Port Radium and Rayrock work has received recently a lot of public attention and thus I am very concerned about the concentrations. For the time being I have not released the concentrations other than in a draft to the scientific authority, and ham requested that they are not released to Health and Welfare for the time being.

I have also enclosed the information on the analytical methods, which are to be published in the appendix of the report. You may want to check the draft, and add may be something about the quantification of the recovery. 1 a m not sure if you have used a carrier for bismuth or not

I hope you excuse m e for bothering you about these numbers again and I trust that you can understand my concern.

Reply ~~to~~ from Gene Smithson ~~by~~ to Margarete Kalin dated April 12, 1984 (discussed over telephone on April 13, 1984).

SECTION B2: MULTIELEMENTAL ANALYSIS

~~2.1~~ University of Toronto, I.E.S.

Neutron activation analysis was carried out on all solid samples from the Port Radium study ie. 1982 by M. Kalin, following the irradiation scheme developed for uranium mill tailings. The silver tailings however contained significant amounts of manganese, which increased the detection limits reported for uranium tailings. Detection limits are thus reported in the data report Appendix pg. 70–81 for each individual sample. A summary of detection limits and errors was given in the Port Radium Report (1983), along with the reported mean concentration of the elements.

Neutron Activation Analysis (by J. Blondal)

Theoretical Considerations. The sample to be analyzed is irradiated with a fixed known flux (ϕ) of thermal neutrons for a specific time (t_{irr}). An element amenable to activation analysis must, in this process, produce an unstable isotope in sufficient yeild to allow detection of its γ ray emissions. All the isotopes pertinent to the present discussion result from (n, γ) reactions, e.g. $^{27}Al(n,\gamma)^{28}Al$ (i.e. $^{27}_{13}Al + ^{1}_{0}n \rightarrow ^{28}_{13}Al + \gamma$). In the above example, ^{28}Al then decays via β^- decay with an accompanying emission of a y ray of energy 1779 keV.

Allowing for a decay time of Δt, the activity $A_{\Delta t}$, of the induced radioactive isotope produced from N atoms of the element in the sample is:

$$A_{\Delta t} = N\phi\sigma(1 - \exp(-\lambda t_{irr}))\exp(-\lambda \Delta t),$$

where: σ is the nuclear reaction cross-section and $\lambda = \ln 2/T_{1/2}$ is the decay constant for the radioactive isotope.

Practical Considerations. The technique employed involved no chemical separation or treatment and is therefore entirely instrumental. A sample is placed in a 1-mL polyethylene vial and is irradiated according *to* one of the following irradiation schemes described in the following table. Water samples are transferred to a fresh vial immediately after irradiation.

Sample Type	Irradiation Time (min)	Reactor Power (kW)	Decay Time (min)
water	6	20	2
soil/tailings	1	2	15 - 20
vegetation	1	10	5 - 15
acid digestions	6	10	10

Following irradiation, the samples were counted for 5 minutes on one of the two X-ray spectrometers. The 4096 channel memory was used. The final print-out yields integrated counts of selected peaks and their adjacent backgrounds of the activated samples γ energy spectrum. Sample-to-dectector distance (that is sample position) is increased for those samples whose associated dead-time would otherwise be significant (> 15-20%).

In practice, the samples' activity is compared to that of a set of standards prepared for each element. Use of such a direct comparison is based on the assumption that the isotopic abundances in both samples and standard are identical for a given chemical element. This is valid for all elements analyzed here.

For a given irradiation scheme (irradiation time t_{irr} and power Z) and decay time Δt, the specific activity F_o (counts rather than decays) is found for a given isotopic standard from the expression:

$$F_o = (P - B)/(\exp(-\lambda \times \Delta t) \times \mu g \text{ element irradiated})$$

in counts per μg per five (5) minutes. Here the expression has been back-extrapolated to $\Delta t = 0$, and P and B are the integrated peak and background counts, respectively.

For those samples irradiated at Z' kW for t'_{irr} and counted at a position "p", a new F_o' corresponding to these conditions can be calculated for each element as follows:

$$F_o' = F_o \times \frac{Z'}{Z} \times \frac{1 - \exp(-\lambda \times t'_{irr})}{1 - \exp(-\lambda \times t_{irr})} \times c_p$$

where C_p is a correction factor determined experimentally by counting an irradiated standard at position "p".

An elemental concentration in a given sample can then be calculated in units of $\mu g/g$ as:

$$(P - B)/(\exp(-\lambda \times \Delta t) \times Wt \times F_{o}')$$

where Wt is the samples weight in grams, Δt is the decay time, P and B are the measured peak and background counts for the appropriate γ ray, and F_{o}' is chosen for the appropriate operating parameters t_{irr}, Z, counting position, and counter.

Errors. A major source of experimental error is derived from the statistics of counting, here: $\sigma = \sqrt{P + B}$. Thus, for a significant net peak (P - B) the error (as a percentage) is given by:

$$\left(\frac{\sqrt{P + B}}{P - B}\right) \times 100\%$$

The approach used in checking whether the counts are significant is as follows: if $P - B > 4.65\sqrt{B}$, then the peak is significant. Otherwise, there is no "real" peak, and an approximate detection limit can be obtained by using $4.65\sqrt{B}$ rather than P - B in the ensuing calculations.

For one of the two counters used, an anomalous net background count was found at the γ ray energy (74.6 keV) corresponding to the ^{239}U isotope used in measuring uranium content. This peak was counted for each analytical run and was subtracted from the sample counts at that γ ray energy. In addition, a correction was made for the contribution of the reaction ^{28}Al (n, p) ^{27}Mg to the ^{27}Mg peak used for magnesium determinations.

A Calculated Example. Suppose a 0.5438-g sample was irradiated at 10 kW for 6 minutes and counted on counter No. 1 at position 4 after Δt = 15 minutes. The F_{o} of the 1811 keV peak of ^{56}Mn (λ = 0.00447 min^{-1}) is 28.8 for an irradiation of 1 minute at 2 kW reactor power. The pertinent F_{o}' is then:

$$F_{o}' = 28.8 \times \frac{10\ kW}{2\ kW} \times \frac{1 - \exp(-0.00447 \times 6)}{1 - \exp(-0.00447 \times 1)} \times 0.450 = 384$$

where C_{p} = 0.450 is the correction factor for the ^{56}Mn 1811 keV peak for position "4".

Peak and background counts for that peak were 2800 and 57 respectively. The concentration of manganese in the sample was then:

$$(2800 - 57)/(\exp(-0.0047 \times 15) \times 384.5 \times 0.5438) = 14.0\ \mu g/g$$

The error associated with counting statistics was:

$$\pm \frac{\sqrt{2800 + 57}}{2800 - 57} \times 14.0\ \mu g/g$$

that is ± 0.3 μg/g, therefore the concentration of Mn in the sample is 14.0 ± 0.3 g/g.

The F, for 1 min at 2 kW and a counting position 1 used for the calculations are given in the following table.

F_o FOR 1 Min AT 2 kW COUNTS AT POSITION I

Element	λ (min^{-1})	F_o Counter 1	(C1) P4/P1	F_o Counter 2	(C2) P4/P1
CO	0.066	504	0.379	472	0.525
U	0.0294	1700	0.384	2290	0.527
Dy	0.00495	3870	0.383	5220	0.525
Ba	0.00835	4.83	0.382	9.09	0.520
Ti			0.386		
Sr	0.00407	1.57	0.388	2.99	0.507
I	0.0276	110	0.390	235	0.547
Br	0.0393	44. 1	0.395	89.7	0.506
Mg	0.0732	0.401	0.420	0.799	0.525
Na	0.00077	1.70	0.437	3.25	0.540
V	0.184	1110	0.443	2010	0.534
Al	0.3000	83.7	0.443	169	0.525
Mn	0.00447	28.8	0.450	51.8	0.533
Cl	0.0185	1.47	0.450	2.78	0.525
Ca	0.0787	0.129	0.450	0.241	0.574

Correction Factor for P8/P1 0.102 and P1O/P1 0.045.

R. Hancock F,: Dy 1550 (our results 50% lower)
Mn 20.5 (our results 30% lower)
C1 = Counter 1
C2 = Counter 2

(Standards run in Dec. & Jan. 1980; J. Blondal)

STANDARD MATERIAL ANALYZED BY NEUTRON ACTIVATION ANALYSIS DURING SAMPLE DETERMINATIONS

		Co	U	Mg	Na	V	Al	Mn	Ca
		μg/g							
N.B.S. Coal No. 1631	our* analysis	5.6 ±0.6	1.66 ±0.12	1 800 ±180	403 ±36	34.3 ±1.4	17 100 ±170	41.0 ±2	2 630 ±290
	given	5.7	1.4	2 000	414	35.0	18 500	40.0	4 300
		(±0.4)	(±0.1)	(±500)	(±20)	(±3)	(±1 300)	(±3)	(±500)
Orchard leaves SRM No. 1571	our* analysis	0.9[a]	0.2[a]	6 220 ±200	58 ±28	0.55 ±0.17	419 ±11	96.8 ±2	13 450 ±400
	given	0.2	0.029	6 200	82	not	not	91.0	20 900
		not certified	(±0.005)	(±200)	(±6)	given	given	(±4)	(±300)

* Errors are calculated as $(\sqrt{P + B}/P - B)\ 100$

( ) = standard deviation

[a] detection limits

Source: EPS-5-WNR-81-1 (Kalin, M.)

Detection Limits and Errors in Neutron Activation Analysis

TYPICAL RANGES OF DETECTION LIMITS IN MATERIALS OF THIS SURVEY

Elements	Water (mg/L)	Soil/tailings (µg/g)	Vegetation (µg/g)
Al	0.06 - 0.4	*	*
Ba	0.4 - 1.0	*	10 - 65
Br	0.01 - 1.5	10 - 70	2 - 10
Ca	2 - 7	300 - 1000	*
Cl	1 - 5	*	*
Dy	0.001 - 0.04	0.2 - 0.8	0.05 - 0.5
I	0.002 - 0.01	1 - 20	1 - 10
Na	*	*	24 - 70
Mg	2 - 20	*	300 - 500
Mn	0.02 - 0.5	*	*
Sr	0.5 - 1.5	150 - 600	64 - 150
U	0.002 - 0.05	*	0.1 - 0.3
V	0.002 - 0.015	*	

The ranges given are based on the materials analyzed in this survey. They do not reflect detection limits and errors of neutron activation analysis in general. The asterisks (*) indicates those instances where sample concentrations are well above detection limits for all samples analyzed. The figures given are typical values; however, isolated samples exist where the values will be considerably lower or higher.

TYPICAL RANGES OF ERRORS (IN PERCENT) ASSOCIATED WITH THE DETERMINATIONS IN THE MATERIAL

Element	Water (mg/L)	Soil/tailings (µg/g)	Vegetation (µg/g)
Al	0.1 - 10	1 - 2	1 - 5
Ba	10 - 25	1 - 15	5 - 15
Br	2 - 20	15 - 30	5 - 20
Ca	3 - 30	1 - 20	1 - 8
Cl	1 - 20	2 - 30	2 - 28
Dy	2 - 25	1 - 10	5 - 25
I	7 - 30	10 - 25	10 - 20
Na	0.3 - 13	0.6 - 1	5 - 15
Mg	1 - 30	2 - 10	3 - 14
Mn	1 - 5	0.5 - 5	2 - 5
Sr	N/A	17 - 30	N/A
U	0.3 - 10	0.4 - 16	3 - 20
V	1 - 10	1 - 10	5 - 20

N/A = not applicable

INDUCTIVELY COUPLED PLASMA EMISSION SPECTROSCOPY

The ICP laboratory at the University of Toronto is in operation since 1981 , and provides simultaneous multielement analysis of various materials. The instrument is operated by Agnes Balicki under the supervision of J. Van Loon.

General principles of the method are well described in the following articles and are not outlined in detail here.

Fassel, A. V.and Kniseley , R.N. 1974 : Inductively coupled Plasma Optical Emission Spectroscopy.Anal. Chem. 46,(13) 1110 A

Ward, A. F, 1984 Inductively coupled Plasma : Optical emission spectroscopy for the analysis of metal alloys - a comparison of simultaneous and sequential approaches. ASTM Standardization news, Feb. 1984.

The instrument at U of Toronto is a model ARL Number 34 000 and performs simultaneous multielement analysis. The Instrument specifications are as follows:

R .F. GENERATOR :	incident power of 1200 W	
	Reflected power 0 5	
EXCITATION :	Observation height	17 mm
	Coolent gas rate	12 l / min
	Plasma gas rate	0.8 l / min
	Carrier gas rate	1.0 l / min
	Meinhardt concentric nebulizer with a flow rate of 2.7 ml / min	
READOUT:	preintegration time	30 sec
	integration time	10 sec
	integration interval	3
SPECTROMETER :	Grating 1080 lines / mm	
	Primary slit size 20 microns	

ANALYTICAL CONDITIONS

Element	Wavelength	Theoretical detection limit
Ti	368.5	0.00575
Th	401.9	0.01106
U	409.0	0.09618
Be	234.9	0.00029
Te	238.6	0.15182
Au	242.8	0.00572
Ba	493.4	0.00025
Si	251.6	0.00836
Fe	259.9	0.00129
Pt	266.0	0.02310
Cr	267.7	0.00243
S	180.7	0.01323
Mg	279.1	0.01373
As	189.0	0.02260
Sn	189.9	0.01581
V	292.4	0.00169
Se	196.0	0.04232
Mo	202.0	0.00682
Al	308.2	0.01646
Ca	317.9	0.00147
Zn	213.9	0.00402
Cu	324.8	0.00230
Sb	217.6	0.03772
Ag	328.1	0.00268
Pb	220.3	0.04601
Cd	226.5	0.00321
Co	228.6	0.00347
Ni	231.6	0.01372
P	178.3	0.03579
W	239.7	0.02574
B	249.7	0.00455
Mn	257.6	0.00060
Mx	0.0	0.00000

2.2 DIAND Laboratory Yellowknife
Heavy Metals Water Reproducibility

TO: M. Kalin, Institute for Environment Studies, University of Toronto

FROM: R. Soniassy, Supervisor Pollution Control, Water Resources Division
Government of Canada

SUBJ: AD HOC Committee on Radioactive Wastes - Port Radium and Rayrock

On September 13, 1983 the results of radionuclide analysis (Lead 210, Radium 226 and Uranium), on 31 water and 23 sediment samples from Port Radium and Rayrock, were sent to you.

I am now sending you the results of heavy metal analysis on 70 water samples (46 from Port Radium and 24 from Rayrock). The results are shown in Table 1, 1 cont'd and 2. The laboratory quality control program is shown in Table 3.

Heavy metal analysis on 23 sediment samples (11 from Rayrock and 12 from Port Radium) remain to be completed to complete the analytical component of this project.

Note: One table was provided for reproducibility of water analysis.
Further details can be obtained from R. Roniassy, DIAND Laboratory, Yellowknife.

~~2.2~~ Heavy Metals **DIAND** Laboratory, Yellowknife

Table **Results of Laboratory Quality Control Program*.**

SAMPLE DESCRIPTION	HEAVY METALS (µg/l) As	Cd	Cu	Fe	Pb	Ni	Zn	Co
4 Cobalt Channel Mid (filtered)	< 1	< 0.05	< 1	68	0.5	< 1	37	< 1
4 (rep 1) Cobalt Channel Mid (filtered)	< 1	< 0.05	< 1	60	0.5	< 1	37	< 1
4 (rep 2) Cobalt Channel Mid (filtered)	< 1	< 0.05	< 1	63	0.5	< 1	38	< 1
6 Labine Bay Outer (unfiltered)	< 1	< 0.05	2.1	42	0.4	< 1	37	< 1
6 (rep 1) Labiie Bay Outer (unfiltered)	< 1	< 0.05	< 1	40	0.4	< 1	39	< 1
6 (rep 2) Labine Ray Outer (unfiltered)	< 1	< 0.05	< 1	45	0.3	< 1	37	< 1
32 V-notch Seepage (unfiltered)	20	< 0.05	5	480	1.5	36	17	6.8
32 (rep 1) V-notch Seepage (unfiltered)	18	< 0.05	6	470	1.5	36	16	6.8
32 (rep 2) v-notch Seepage (unfiltered)	16	< 0.05	7	480	1.5	36	15	6.8
36 Garbage Lake 12, # 4 (unfiltered)	300	0.06	14.4	3,400	4.3	72	32	32
36 (rep 1) Garbage Lake 12, # 4 (unfiltered)	300	< 0.05	19.4	3,500	4.2	74	34	32
36 (rep 2) Garbage Lake 12, # 4 (unfiltered)	290	< 0.05	13.4	3,400	4.9	77	32	31
Limit of Detection	< 1	< 0.05	< 1	< 5	< 0.1	< 1	< 5	< 1

*triplicate analysis of water samples, Echo Bay Mines, Port Radium, *sampled* July 1983.

NOTE: One table was provided for reproducability of water analysis. Further details can be obtained from R. Soniassy, **DIAND** Laboratory, Yellowknife.

DIAND Laboratory Yellowknife

TO: M. Kalin, Institute for Environmental Studies, University of Toronto

FROM: R. Soniassy, Supervisor Pollution Control, Water Resources Division
Government of Canada

SUBJ: Heavy Metal Analysis: Port Radium & Rayrock

I am enclosing the results of heavy metal analysis on the sediment and tailings samples from Rayrock and Port Radium (Tables 1 and 2). All results are expressed on the dry matter.

The quality control data for As, Cd, Cu, Fe, Pb, Zn and Co are shown as Rep 1 and Rep 2 in Tables 1 and 2. The quality control data for Hg is shown in the footnote in Table 2.

I tried to send these data by DEX but the University of Toronto does not have a unit compatible into ours. If there are any questions on these results, please phone me at (403) 920-8243.

HEAVY METALS SOLIDS REPRODUCIBILITY

SAMPLE DESCRIPTION	HEAVY METALS (mg/kg)							
	As	Cd	cu	Fe	Pb	Hg	Zn	co
Silver Pt. Tailings, Coarse Mid. Cut	2,135	0.8	4,180	41,400	1,263	2.6	826	261
Silver Pt. Tailings, Coarse Mid. Cut, Rep 1	2,249	0.8	4,600	43,030	1,261		832	208
Silver Pt. Tailings, Coarse Mid. Cut, Rep 2	2,044	0.9	4,690	37,880	1,309		841	237
West Adit North, Mid. Coarse	1,889	2,67	7,490	46,330	719	0.8	1,820	2,155
West Adit North, Mid. Coarse, Rep 1	1,542	2,84	7,320	49,160	727		2,130	1,764
West Adit North, Mid. Coarse, Rep 2	810	2.82	7,220	42,310	747		1,700	1,482
P2, Bottom	18.1	0.18	53	23,410	6.1	0.05	296	11.6
P2, Bottom, Rep 1	17.6	0.17	54	24,890	5.9		278	10.5
P2, Bottom, Rep 2	18.0	0.18	55	20,590	6.1		304	10.7
Lake Alpha, Sediments	33.6	0.26	125	32,440	8.4	0.12	247	14.3
Lake Alpha, Sediments, Rep 1	33.8	0.22	126	38,220	9.2		252	16.9
Lake Alpha, Sediments, Rep 2	30.0	0.22	127	38,120	8.9		250	19.9

MERCURY ANALYSIS QUALITY CONTROL DATA

Standard River Sediment quoted to contain 1.1 ± 0.5 mg/kg mercury was analyzed at 1.2, 0.91, 0.78, 1.1, 0.81, 0.76, 0.78 and 1.0 mg/kg mercury.

SECTION B3: pH, CONDUCTIVITY AND CONVERSIONS

3.1 Diand Laboratory, Yellowknife

Table Quality control for pH and conductivity of sediments.

SAMPLE	ONE HOUR AFTER MIXING		THREE HOURS AFTER MIXING		FIVE HOURS AFTER MIXING		24 HOURS AFTER MIXING	
	pH	Cond. at 25 °C µmhos/cm	pH	Cond. at 25 °C µmhos/cm	pH	Cond at 25 °C µmhos/cm	pH	Cand at 25 °C µmhos/cm
Conductivity standard	-	-	-	1378	-	1462		1497
Fresh conductivity standard		1443	-	1420	-	1423	-	1435
Blank	5.72	1.3	5.02	1.3	5.59	1.5	5.69	1.6
Fresh Soln B	6.91		6.89	323	6.88	322	7.02*	323
Soln B1	6.87	315	6.81	324	6.89	322	7.05*	331
Soln B2	6.89	309	6.89	325	6.88	323	7.07*	318

BUFFER pH READINGS

pH BUFFER	ONE HOUR	THREE HOUR	FIVE HOUR	24 HOUR
10.4	10.4	10.28*	10.12*	10.3*
7.0	7.01	7.02	7.0	7.22*
4.0	3.99	3.99	3.98	3.88*

* = out of control

Conductivy Standard should read 1413 µmhos/cm.

Conductivity: Conductivity of Solution B was within control limits for all measurements. Conductivity of fresh conductivity standard was within control limits. Measurements on the same portion of conductivity standard solution tended to increase until they were over the upper warning limit (5 h after mixing). Overall QC results would indicate conductivity results are valid in spite of the coating which accumulated on the conductivity probe.

pH: pH buffers were not reading within control limits as time passed. Control solution B gave results that were out of control by the time the 24 h reading was taken. The pH electrode may have become coated during the analysis After cleaning, the electrode returned to normal. The pH results for the 24 h measurement, are likely inaccurate. pH measurements took about 1/2 h and then conductivity measurements 1/2 to 3/4 h for the series times stated are for start of pH measurements. There was some solution loss during rinsing of the pH electrode and conductivity probe (and some evaportion) so that there was insufficient solution at the 24 h reading to give a good conductivity measurement on some sediment solutions.

pH and conductivity of sediments in Rayrock

SAMPLING STATIONS		ONE HOUR AFTER MIXING		THREE HOURS AFTER MIXING		FIVE HOURS AFTER MIXING		24 HOURS AFTER MIXING	
Number	Area	pH	cond at 25 °C (μmhos/cm)	pH	Cond. at 25 °C (μmhos/cm)	pH	cond. at 25 °C (μmhos/cm)	pH	Cond. at 25 °C (μmhos/cm)
1T1	P1	4.2	210	4.1	240	4.2	270	4.1	340
1T2	P2 surf	6.0	250	6.1	320	6.2	350	6.6	400
1T2	P2 middle	5.0	770	6.0	910	5.0	920	5.0	1000
1T2	P2 bottom	5.7	240	5.6	260	5.6	270	5.7	310
1T3	P3	5.6	54	5.6	62	5.7	61	6.0	81
1T4	P4	4.5	600	4.5	670	4.5	690	4.5	800
1T6	C2	6.0	97	6.1	110	6.1	120	6.3	140
1T8	surface encrust*	4.4	13,000	4.3	13,000	4.2	13,000	4.1	14,000
4T1	Lake Alpha	5.2	790	5.1	920	5.1	980	5.2	1100
Z01S	Control soil	6.6	97	6.5	94	6.5	100	6.6	130
1T7	C3	6.0	93	6.0	100	6.1	110	6.2	120

*25 g sediment + 150 ml deionized distilled water used for this sample
50 g sediment + 150 ml de-ionized distilled water used for all other samples

pH and conductivity of sediments in Port Radium

SAMPLING STATIONS		ONE HOUR AFTER MIXING		THREE HOURS AFTER MIXING		FIVE HOURS AFTER MIXING		24 HOURS AFTER MIXING	
Number	Area	pH	Cond. at 25 °C (μmhos/cm)	pH	Cond. at 25 °C (μmhos/cm)	pH	Cod at 25 °C (μmhos/cm)	pH	Cond. at 25 °C (μmhos/cm)
8T4	Silver Point	8.0	570	7.9	630	7.8	680	8.0	760
8T5	Coarse middle cut	8.3	970	a3	1100	8.3	1100	8.3	1200
9T12	Profile # 1	4.4	450	44	890	4.4	1100	4.4	1100
9T10	hfile # 2	4.3	4200	43	4100	4.3	3800	4.3	3800
9T10	Profile # 2 peat)	3.8	3500	3.8	3700	3.8	3700	3.8	3800
9T7	Profile # 3	5.2	7700	5.4	6500	5.4	6400	5.6	6000
9T11	Profile # 4	3.8	4100	38	4000	3.8	3900	3.8	3700
9T13	West Adit	-6.9	980	as	1100	6.8	1100	7.2	1300
1T15	# 3 Garbage	-8.5	620	6.2	740	8.3	830	8.4	950
1T1	# 1 Garbage	-7.9	1100	7.9	1100			6.0	1300
6S3	Murphy Bay	8.8	170	8.8	180	8.7	190	8.7	220
5S12	LaBine Bay	-7.3	130	72	150	72	170	7.4	190

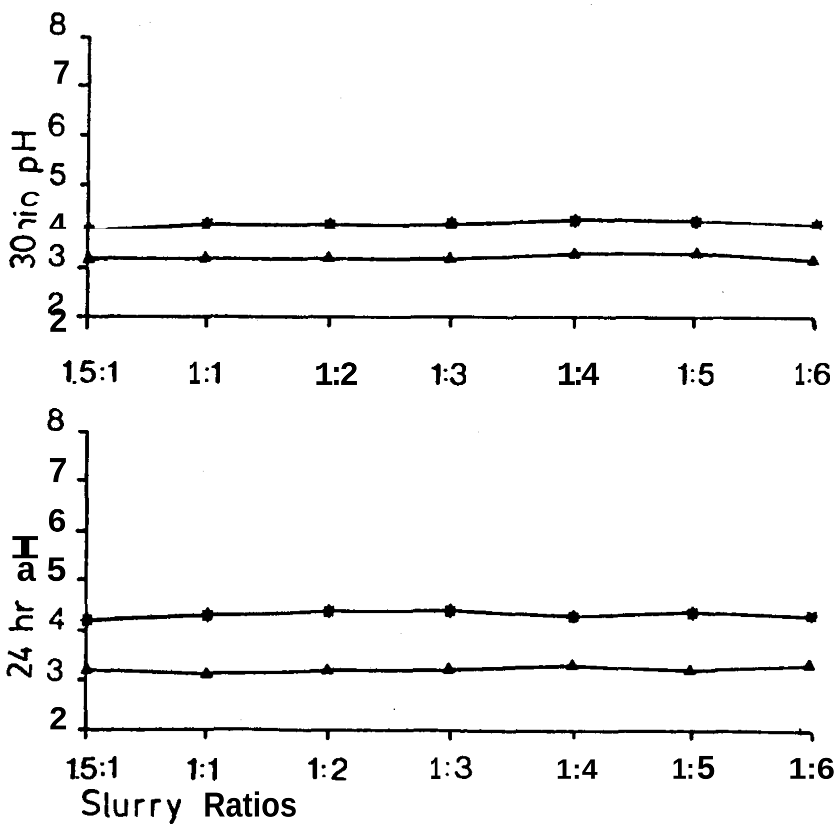
SECTION B3: pH, CONDUCTIVITY AND CONVERSIONS

3.2 University of Toronto, I.E.S.: M. Kalin source

The determination of wet/solid ratio for measurement of pH and conductivity is required to ascertain comparability of the material to other tailings. Repeated measurements (30 min and 24 h) indicate the reliability of the value. These laboratory determinations are used to evaluate the field results.

Slurry Ratios Liquid/Solid for pH and conductivity measurements for West Adit Material

pH measurements (site 9T2 and 9T6)



conductivity measurements (site 9T2 and 9T6)

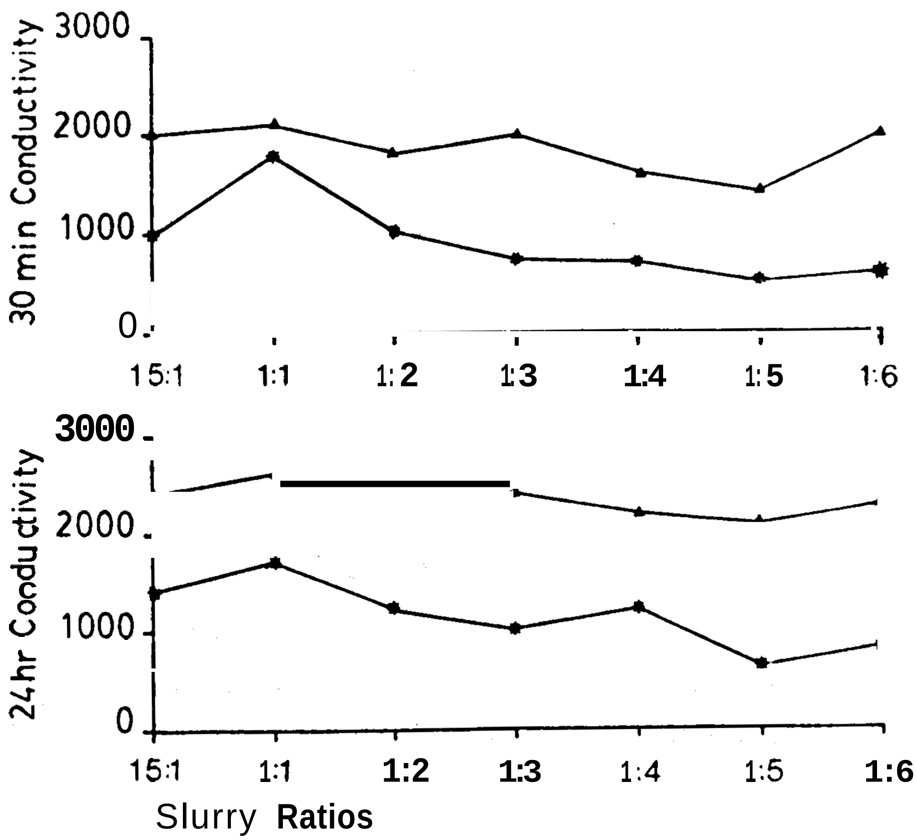


Table : **Conversion of Pb-210 and Ra-226 from Bq/l to pC/l and U from µg/l to mg/l**

SRC CODE	STATION SITE	Pb-210 Bq/l	Pb-210 pC/l	Ra-226 Bq/l	Ra-226 pC/l	URANIUM µg/l	URANIUM mg/l
5538	1W 0811*	0.04	1.08	0.02	1.09	61± 9	.061± .009
5537	1W 0813*	0.05	1.35	0.07	1.89	92± 10	.092± .10
5521	2W 06*	0.11	2.97	0.01	0.27	0.6± 0.2	.0006± 0.0002
5573	2W 07*	< 0.02	< 0.54	0.01	0.27	4.1± 0.9	0.0041± 0.0009
5532	3W 03*	0.10	2.70	0.01	0.27	0.8± 0.2	0.0008± 0.0002
5520	3W 04*	0.45	12.16	0.01	0.27	1.0± 0.2	0.001± 0.0002
5539	4w 02*	0.25	6.76	<0.005	<0.14	3.7± 0.9	0.0037± 0.0009
5526	5W 08*	< 0.02	< 0.54	0.01	0.27	1.3± 0.2	0.0013± 0.0002
5529	5W 09*	0.02	0.54	0.02	0.54	8.4± 1.0	0.0084± 0.001
5527	5W 11*	0.08	2.16	0.01	0.27	3.2± 0.1	0.0032± 0.0001
5528	5W 12*	0.40	10.81	0.01	0.27	1.9± 0.2	0.0019± 0.0002
5525	5W 13*	0.35	9.46	0.11	2.81	15± 1	0.015± 0.001
5522	5W 14*	0.05	1.35	0.01	0.27	1.6± 0.2	0.0016± 0.0002
5535	8W 01**	0.14	3.78	0.40	10.81	4200	4.2
5536	8W 01*	1.9	51.36	3.0	81.09	5800	5.8
5530	9W 01*	1.9	51.36	0.40	10.81	351± 88	0.351± 0.088
5531	9W 02*	0.30	8.O	0.01	0.27	1.4± 0.2	0.0014± 0.0002
5534	13W 02*	0.04	1.08	0.11	2.81	5.5± 0.9	0.0065± 0.0009
5524	K03W 01*	0.25	6.76	< 0.005	< 0.14	1.3± 0.2	0.0013± 0.0002
5523	K04W 01*	0.35	9.45	0.01	0.27	1.6± a2	0.0016± 0.0002

* = unfiltered
** = filtered

Table : Conversion of Re226 and Pb-210 from Bq/l to pCi/l and U from µg/l to mg/l.

SRC CODE	SAMPLE CODE	STATION/ SITE*	Pb-210		Ra-226		URANIUM	
			Bq/l	pC/l	Bq	pC/l	µg/l	mg/l
5509	4w 1	Lake Alpha water	0.05	1.35	0.40	10.81	4.7± 0.9	0.0047
5510	4W 1	Lake Alpha bottom water	0.90	24.33	0.70	18.92	4.9± 0.8	0.0049± 0.0009
5511	1W 1	Creek Alpha Water	1.1	29.73	3.0	81.09	20± 1.0	0.02± 0.001
5512	9W 1	Mill Lake water	0.10	2.70	0.45	12.16	330± 82	0.33± 0.082
5513	6W 1	Sherman 4 Water	0.55	14.87	0.02	0.54	1.2± 0.2	0.0012± 0.0002
5514	6W 2	Sherman 14 water	0.06	1.62	0.01	0.27	3.9± 0.9	0.0039± 0.0009
5515	7W 2	Lake A mid station water	0.03	0.81	0.04	1.08	0.7± a2	0.0007± 0.0002
5516	8W 1	Lake B water	< 0.02	< 0.54	0.01	0.27	-	-
5517	5W 1	Lake Beta Water	0.25	6.76	0.40	10.81	7.7± 0.9	0.0077± 0.0009
5518	3W 1	Lake Gamma Water	0.20	5.41	40	108.12	11± 1	0.01± 0.001
5519	K01W	Control Lake water	0.07	1.89	0.04	1.08	1.2± 0.2	0.0012± 0.0002

* = all samples are unfiltered.

Table : **Conversion of Ra-226 and Pb-210 for Port Radium tailings.**

SRC CODE	SAMPLE CODE	SITE DESCRIPTION	Pb-210 Bq/g	Pb-210 pCi/g	Ra-226 Bq/g	Ra-226 pCi/g
5551	8T4	Silver Point tailings (water logged)	20	54.06	25	67.58
5552	8T5	Silver Point tailings (coarse middle cut)	0.18	4.87	0.70	18.92
5553	9T9	Profile # 1	3.5	946.05	3.5	946.05
5554	9T10	Profile # 2 (top coarse)	30	810.9	30	810.9
5555	9T10	Profile # 2 (peat)	12	324.36	14	378.42
5556	9T11	Profile # 3 (top coarse)	25	675.75	25	675.75
5557	9T12	Profile # 4 (top coarse)	25	67575	30	810.9
5558	9T13	West Adit (middle coarse)	25	675.75	30	810.9
5559	1T5	Grab	0.9	24.3	2.0	54.06

Table : Conversion of Ra-226 and Pb-210 from Bq/l to pCi/l.

SRC CODE	SAMPLE CODE	STATION/ SITE	Pb-210 Bq/l	Pb-210 pC/l	Ra-226 Bq	Ra-226 pC/l
5540	2T1	P1 Gamma (fine surface)	110	2973	120	3244
5541	2T2	P2 Gamma (surface)	20	541	17	460
5542	1T2	P2 middle	18	487	14	378
5543	1T2	P2 bottom	0.30	8.0	0.25	7
5544	1T3	P3 10 cm	12	324	12	324
5545	1T4	P4 surface	35	946	35	946
5546	2T6	C2 Gamma surface	13	351	14	378
5547	1T8	Surface encrustment in 2nd discharge.	20	541	20	540
5548	4T1	Lake Alpha sediments	0.30	8.1	0.75	20
5549	201S	Control Soil 1	0.12	3.2	0.01	0.27
5550	1T7	c3	30	811	25	676

3.3 EPS Laboratory

Methods for Water

a) Laboratory - Environmental Protection Service, Edmonton
Parameter - Arsenic
Methods - $H_2O_2:HNO_3$ digestion; addition of nickel nitrate solution and atomic absorption (graphite furnace) determination.
Reference - U.S. EPA Manual of Methods for Chemical Analysis of Water and Wastewater, 1976.

b) Laboratory - Environmental Protection Service, Edmonton
Parameter - Mercury
Methods - $H_2SO_4:HNO_3:KMnO_4:K_2S_2O_3$ digestion followed by cold vapour atomic absorption determination.
Reference - U.S. EPS Manual of Methods for Chemical Analysis of Water and Wastewater, 1976.

c) Laboratory - Environmental Protection Service, Edmonton
Parameter - Nickel, copper, zinc, cadmium, cobalt, iron, magnesium, manganese.
Methods - $NHO_3:HCl$ digestion followed by atomic adsorption determination.
Reference - U.S. EPS Manual of Methods for Chemical Analysis of Water and Wastewater, 1976.

Sediment

Samples were dried and digested according to methods described in:
Inland Waters Directorate (Environment Canada). 1979. Analytical Methods Manual. Water Quality Branch, Burlington, Ontario. (unpublished)

Analysis was carried out as outlined above, for water.

EVALUATION OF ACID PRODUCTION POTENTIALS OF URANIUM TAILINGS SAMPLES SUBMITTED BY EPS - YELLOWKNIFE.

4.1 BC Research, Division of Extractive Metallurgy

Introduction

Objective: To determine the add production potentials of eight uranium tailings samples received from the Environmental Protection Service, Yellowknife Branch.

Background: Many materials that contain sulphur and sulphide materials can be oxidized microbiologically to sulphuric acid end soluble metal sulphate salts by the leaching bacterium *Thiobacillus ferrooxidans*. This phenomenon can result in a potential water pollution hazard if the amount of sulphuric acid which the bacteria produce exceeds the neutralizing capacity of the host rock. If this is the case, acidic drainage water will occur, which may also solubilize heavy metals which could be toxic to aquatic flora and fauna in the area. BC Research has developed a two-part test which allows prediction of the add producing potential of a particular sample (Appendix 1). This test has been used to analyze eight tailings samples received from EPS - Yellowknife.

A number of wet tailings pulp samples were received from Yellowknife and the University of Toronto on December 8 and 9, 1983. These samples had been labelled as follows:

BCR#	SAMPLE DESCRIFTION	SOURCE
1	PR-5S13	Yellowknife
2	PR Profile # 3,4 Top coarse tailings	Yellowknife
3	PR-3s	Yellowknife
4	Labiie Bay 5S4	U of T
5	RR-P1 Gamma Fines Surface	Yellowknife
6	RR-P2 Gamma Surface	Yellowknife
?a	WOSOTO1 P-4 Surface	U of T
7b	WOSOTO2 10 cm	U of T
8	*Silver* Point Tailings	Yellowknife

Each pulp sample was dried at 60 °C and rolled thoroughly to homogenize. At the request of Margarete Kalin of the University of Toronto, samples # 7a and # 7b were combined into a composite sample designated 'P4-Gamma Composite'. Therefore a total of eight *samples* were tested for their acid production potential.

The results of the acid production potential tests have revealed that the PR-3S, Labine Bay 5S4, RR-P1-Gamma Fines *Surface* and Silver Point tailings *samples* are non-acid producers. The remaining samples, i.e. PR-5S13, PR Profile # 3, 4-top coarse tailings, RR-P2-Gamma Surface and P4-Gamma Composite have all been classified as potentially weakly acid producing.

Results

Titration Tests: The results of the titration *tests* are summarized in Table 1. Samples # 3, 4, 5 and 8 all clearly consumed substantially more add than could theoretically be produced. Therefore, these samples did not require the confirmation tests

Samples # 1 and 2 consumed significantly less acid than could theoretically be produced. These *samples* required the confirmation test.

Samples # 6 and 7 exhibited a very low and only slightly excess acid consuming ability over acid producing ability, and were classified as 'marginal' cases. Therefore, these samples underwent the confirmation test.

Confirmation Tests: The confirmation test results are [redacted] in Table 2. The samples required acid additions over a two to five day period to attain test pH's optimum for biochemical sulphide oxidation, at which time each test was inoculated with an active culture of *T. $a-m*——— As sulphide oxidation occurred, pH's decreased and eventually stabilized during periods ranging from three to 20 days. At this pint the tests received further incremental additions of *sample* and, after 72 hours, the final pH values, which indicate the add producing capability of the samples, were recorded.

The end-pH values ranged from 265 to 3.48. BC Research classifies samples with final pH's lower than 2.0 as potentially strongly aid producing, pH's between *20* and 2.5 as moderate add producers, and pH's between 2.5 and 35 as *weak* acid producers. Based on this arbitrary scale, all four tailings samples were classified as potentially weakly add producing.

Discussion

The results of the add production potential testa have revealed that the PR-3S, Labine Bay 5S4, RR-P1-Gamma Fines Surface and Silver Point tailings samples are non-acid producers. Any localized acid production will most likely be neutralized by surrounding material. The PR-5S13, PR Profile # 3, 4-top coarse tailings, RR-P2-Gamma surface and F4-Gamma *Composite* samples have all been classified as potentially weakly acid producing. Material of these types may generate acidic effluents if left *exposed* to sufficient air and water to support biological growth.

We emphasize that the foregoing tests, performed under conditions ideal for biological activity, do not address rates of add production or add consumption expected under actual *conditions* of tailings disposal.

1

Sample	pH before addition of extra sample	pH after addition of 0.5 x original weight	pH after addition of 1.0 x original weight	Confirmed acid producer
6S3	2.05	3.04	3.48	yes-weak
9T11	1.78	2.28	2.75	yes-weak

Table Initial acid production test.

Sample Code	Site	% S	Theoretical Acid $kg\ H_2SO_4$ /tonne	Natural pH 10 g sample + 100 ml H_2O	Acid Consumption $kg\ H_2SO_4$ /tonne	Potential Acid Producer
6S3	Murphy Bay Sediment	0.80	24.5	9.31	16.7	yes
9T11	West Adit Surface Course	1.76	53.9	5.38	10.1	yes
1S5	Garbage Lake	1.06	32.4	8.82	167.8	no
5S4	Labine Bay sediment	1.07	32.7	8.01	87.3	no
3T5	Silver Point Tailings	0.92	28.2	8.64	109.8	no

B.C. RESEARCH APPENDIX I
TEST PROCEDURES FOR EVALUATING ACID PRODUCTION POTENTIAL OF ORE AND WASTE ROCK.

Initial Test (Chemical)

Sample: The sample must be taken in such a manner that it is truly representative of the type of mineralization being examined. A composite consisting of split drill core or randomly selected grab samples should be satisfactory. The number of samples to be examined will depend on the variability of the mineralization and must be left to the discretion of the geologist. The bulk sample is crushed to a size which can be conveniently handled (i.e. -5 cm), thoroughly mixed, and coned and quartered to obtain a representative 1 kg sample. This sample is then ballmilled to pass a 400 mesh screen, dried at 60 °C, and is used for sulfur assay, the titration test and if necessary the confirmation test

Assay: The ballmilled sample is assayed in duplicate for total sulfur in a Leco furnace. The acid production potential of the sample, expressed as kilogram (kg) of sulfuric add per tonne of sample, is calculated on the basis of the total sulfur assay.

Titration Test: Duplicate 10 g portions of the ballmilled sample are suspended in 100 ml of distilled water and stirred for approximately 15 minutes. The natural pH of the sample is recorded. The sample is then titrated to pH 3.5 with 1.0 N sulfuric acid on a radiometer automatic titrator. The test is continued until less than 0.1 ml of acid is added over a 4 h period The total volume of acid added is recorded and converted to kg per tonne of sample. This is the acid-consuming ability of the sample, i.e. acid-consuming ability (kg/tonne):

$$= \frac{\text{ml of } 1.0\, N\, H_2SO_4 \times 0.049 \times 1000}{\text{wt of sample in g}}$$

or for a 10 g sample

$$= \text{ml of } 1.0\, N\, H_2SO_4 \times 4.9$$

Interpretation: If the acid consumption value (in kg of acid per tonne of sample) exceeds the acid-producing potential (kg per tonne), the sample will not be a source of acid mine drainage and no additional work is necessary. If the acid consumption is less than the acid production potential, the possibility of acid mine water production exists and the confirmation test is conducted. The sample is titrated to a pH of 3.5 and no lower because of the possibility of growth of the acid-generating bacterium *Thiobacillus ferrooxidans* at pHs below 3.5.

Confirmation Test (Biological)

Shakeflask Leaching Test: Duplicate 30 g portions (or a smaller amount if the sulfide content exceeds 2 percent) are placed in 250 ml Erlenmeyer flasks with 70 ml of a nutrient medium containing 3 g/l $(NH_4)_2SO_4$; 0.10 g/l KCl; 0.50 g/l K_2HPO_4; 0.50 g/l $MgSO_4 \cdot 7H_2O$; 0.01 g/l $Ca(NO_3)_2$. Sufficient sulfuric acid is added (either 12 or 38 N) to bring the pH to 2.5. The flasks are shaken for approximately 4 h during which the pH should be between 2.5 and 2.6. If necessary additional acid is added until the pH remains in that range. The flasks are inoculated with 5 ml of an active *Thiobacillus ferrooxidans* culture. The weight of the flasks and contents are recorded and the flasks are capped with a loose cotton plug and incubated at 35 °C on a gyratory shaker.

Before monitoring or sampling the experimental leach flasks, distilled or deionized water is added to replace that lost by evaporation. The pH and concentration of a dissolved metal (e.g. iron copper or zinc, if applicable) are monitored for the first three days to ensure that the pH remains below 2.8. Thereafter, the pH is recorded every second day until microbiological activity has ceased (as evidenced by a steady pH or dissolved metal concentration) or until the pH drops to 1.8.

When microbiological activity has ceased, half the weight of feed originally used is added (15 g), the flask is shaken for 24 h and the pH is recorded. If the pH is greater than 3.5, the test is terminated. If it is 3.5 or less, half the weight of feed (15 g) is again added and the flask is shaken for 24 h. If the pH is less than 3.5 or greater than 4, the test is terminated. Otherwise, the sample is shaken for an additional 48 h and the final pH is recorded.

Interpretation

The object of this test is to determine if the sulfide-oxidizing bacteria can generate enough sulfuric acid from the sulfides present to satisfy the acid demand of the sample. Experience has shown that not all sulfide minerals are amenable to microbiological attack nor do they all oxidize completely, so that the acid production potential indicated by the sulfur assay may be excessive. If the bacteria generate the acid, microbiological action will continue on a self-sustaining basis once it becomes established, and acidic mine water will result. In this test, the add demand is satisfied initially by adding *sulfuric* add This permits the bacteria to generate the maximum amount of sulfuric add from the sample concerned. Once microbiological action has ceased, half the original sample weight is added If there has not been sufficient acid production, the pH will approach the natural pH of the sample (i.e. above pH 3.5) and the sample is reported as not being a potential source of acid mine water. If the pH remains at 3.5 or below, the remainder of the sample is added *and* the sample is shaken for *up* to 72 h before measuring the final pH. If the pH is *still* in the leaching range, i.e. pH 3.5 or below, then? is a strong possibility that natural leaching will occur and acid mine drainage will be produced. If the pH is above 3.5, there is no possibility of add mine drainage occurring.

If the sample produces excess acidity, there is the possibility of metal recovery by microbiological leaching. A measure of this potential can be obtained by estimating the percentage of the contained metal which has been solubilized during the leaching test. Under such circumstances, it may be desirable to promote microbiological action as a means of recovering valuable metals from a waste material. In such a system, suitable precautions must be taken to prevent the metal and acid-rich leach waters from entering the natural drainage system of the surrounding area.

A degree of caution must be exercised in extrapolating the test results to coarser samples. Both the available surface area and the amount of exposed sulfides will be reduced leading to a reduction in both the acid consumption and the potential acid production. Experience has shown that generally relatively more gangue than sulfides is exposed at the larger particle *sizes,* although this may not always by the case.

APPENDIX C

C1 Detailed summaries of Port Radium data-- 1983

C2 Detailed summaries of Port Radium data- 1982

APPENDIX C

THE CLUSTER ANALYSIS

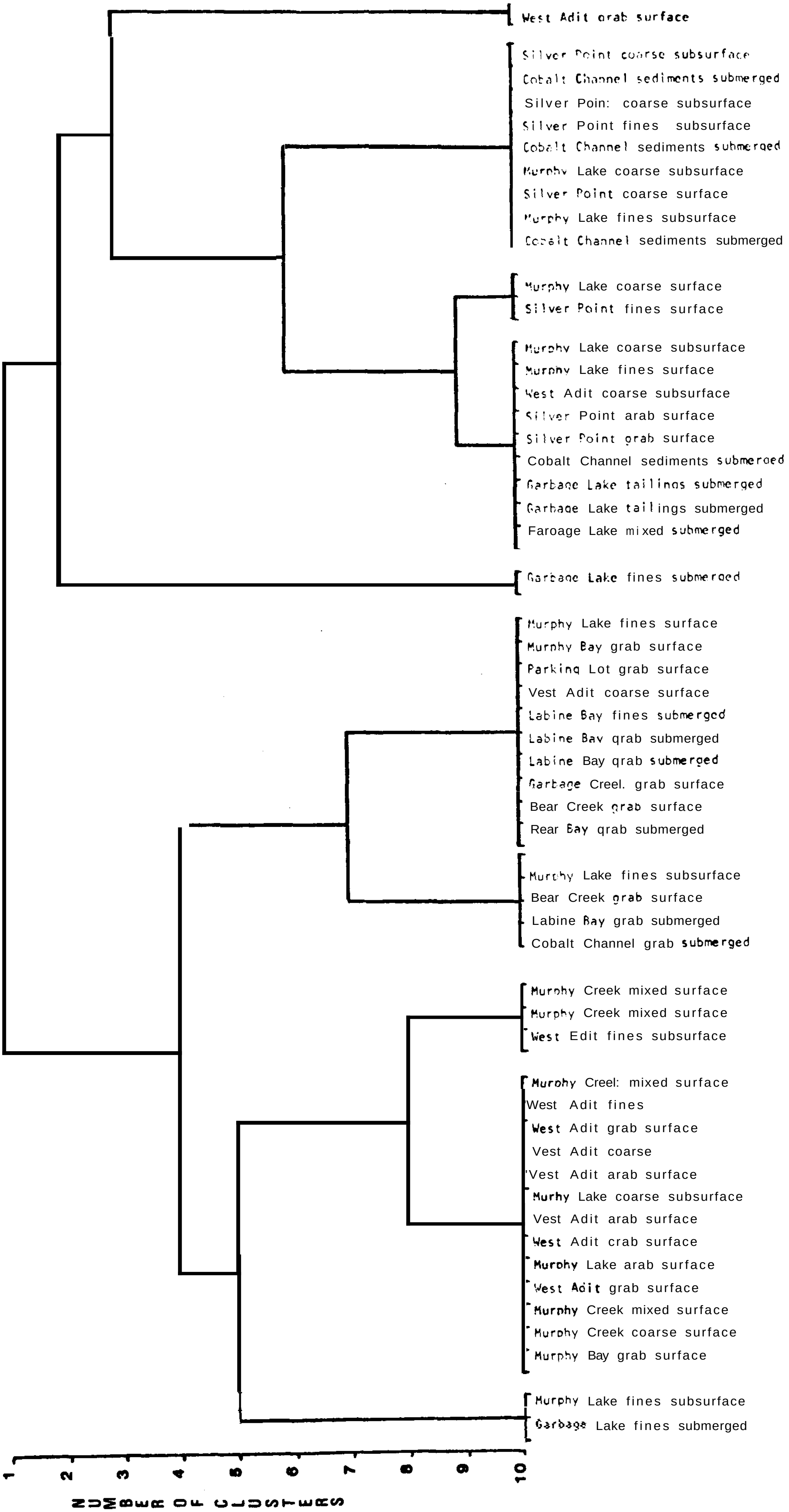
Fifty-four solid samples were analyzed by neutron activation at the Slowpoke facility at the University of Toronto for U, Ca, Mg, Mn, Dy, Ba, Na, Va, Co, Al and Cl. A cluster analysis was used to determine whether the obvious differences in pH and Ra-226 and Pb-210 concentrations between the waste materials are also evident from elemental concentration differ-ences determined tiv neutt-nri act ivat.1on.

A dendrogram depicts the results of Ward's Minimum Variance Hierarchical Cluster Analysis (SAS , 1981) . This analysis initially considered all samples as individual clusters, then systematically groups these samples according to their elemental similarities until one one cluster remains. In the case of a detection limit for an element , a 'concentration' of half the analytical detection limit was assumed. The dendrogram presented (C2) shows, first, the order of sample similarity, ie. the samples on the left are most differentiated from those on the right. Secondly, the dendrogram delineates the clusters for the final 10 groups .

When three main clusters are considered, two major groups are differentiated while the third cluster is comprised of a single Garbage Lake sample. Murphy Creek and Bay are in the same cluster as the materials from West Adit. When the samples are clustered into four groups, West Adit , Murphy Creek and Murphy Bay are generally mare closely related in elemental composition to the sediment samples in LaBine Bay and Cobalt Channel that to the material in Garbage Lake , Murphy Lake and the Silver Point tailings.

Clustering on the fifth level separates the locations further into Murphy Creek, West Adit , Sediments , Gar-baqe Lake and those of Murphy Lake and finally differentiates the material from Silver point:.. These wastes on the various locations are thus not only different in their radionuclide concentrations, pH and physical characteristics, but %heir different origin is also expressed in their elemental composition.

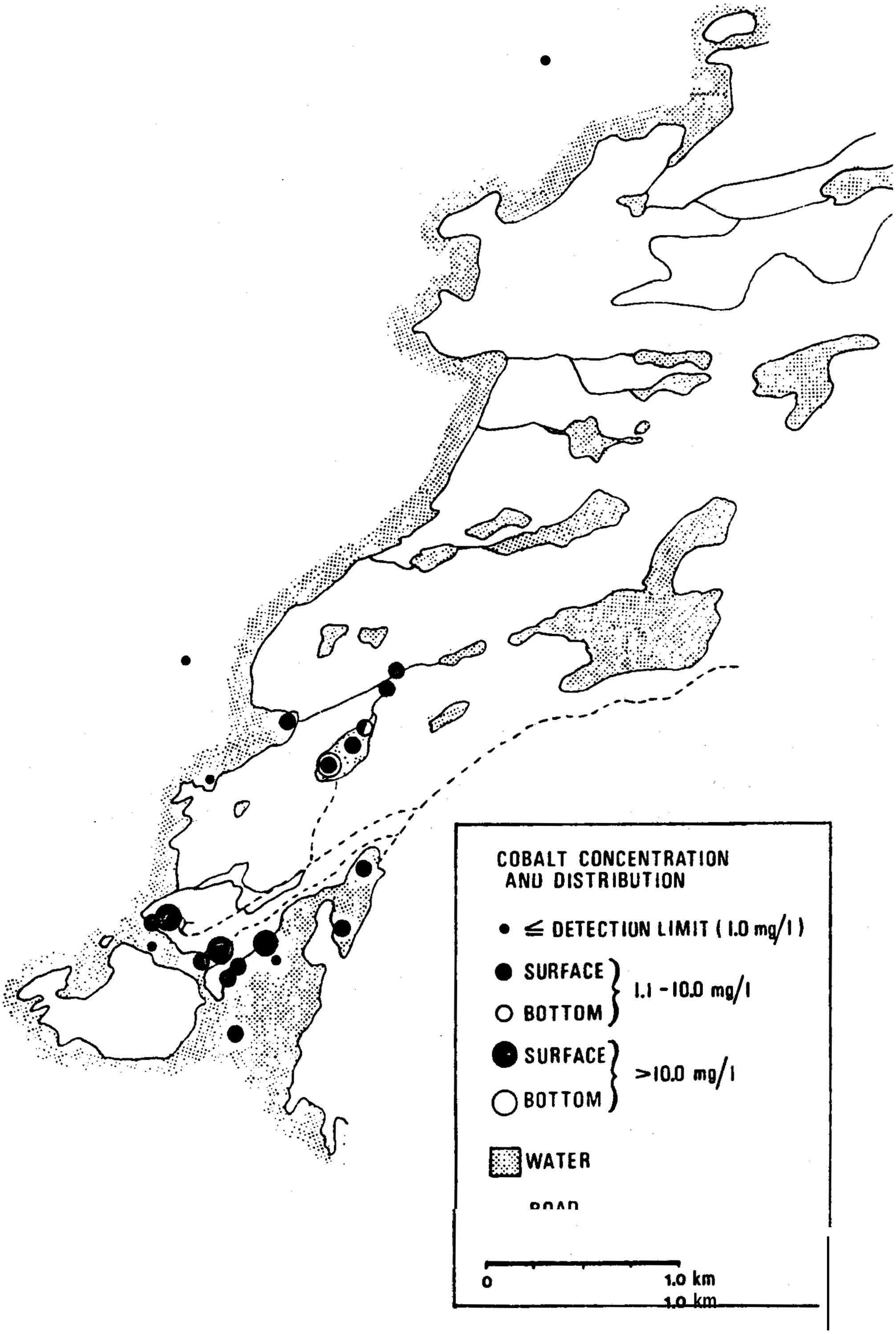
Dissection of all tailings samples collected in the Port Radium vicinity into one to ten clusters, forming a dendrogram. Grouping of the samples is computed using their relative concentrations of eleven elements.



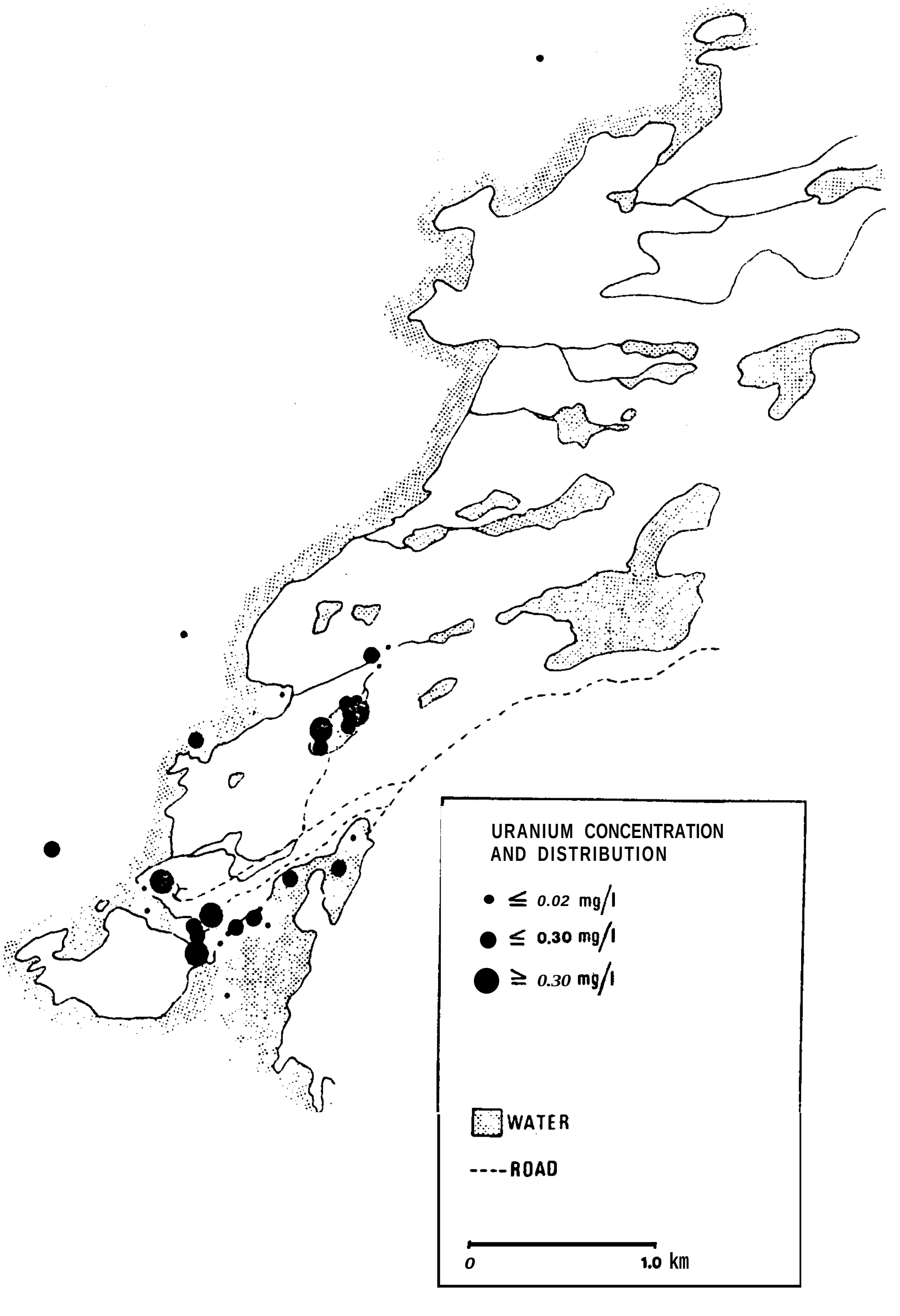
Summary of limnological profiles

Site	T °C max	T °C min	T °C flux*	O.D. max	O.D. min	O.D. flux*	pH flux*	Cond.	Depth total	Depth meas.	Secchi depth
Labine B Middle Outer	22	1.9	surface to bottom	11.8	11.8	none	7.8 surface only	-	-	15m	-
Labine B Inner Middle	a5	3.8	bottom to surface	122	47	bottom to surface	-	-	9m	9m	5
Inner Labine B (north)	12.9	4.4	bottom to surface	13.2	128	none	-	-	5.5	5.5	5.3
Labine B (south)	12.8	4.5	bottom to surface	133	12.6	towards middle	-	-	8.0	5	5.3
20m south of cobalt Island	22	2.0	none	132	13	none	7.9	100**	6.0	8	6
100m east of Cobalt Island	22	22	none	13.5	13.06	none	7.4	160**	78	15	21
Cobalt Channel	25	24	none	12.4	12.2	none	-	-	80	15	-
West Bear Bay	23	2.3	none	13.2	128	surface to bottom	-	-	10	10	-
Inner Bay	3.0	3.4	none	13.7	13.3	none	-	-	3	3	-
Control (north)	21	21	none	13	12.9	none	-	-	-	15	-
Control (south)	20	2.0	none	134	13.2	none	-	-	-	2	
5S16	23	22	none	128	124	none	-	-	90	15	
Garbage Lake # 1	19.0	4.5	bottom to surface	120	8.2	towards middle	8.2	400**	8.2	8	
Garbage Lake # 2	19.0	4.5	bottom to surface	10.8	8.8	surface to bottom	8.4	340**	7.3	7	4.0
Garbage Lake # 3	19.0	4.0	towards middle	10.5	7.0	middle	8.4	320**	11	11	3.8
Garbage Lake # 4	18.7	4.8	bottom to surface	11.7	9.7	surface to bottom	8.4	320**	6.1	8	3.9

* - flux indications direction of increase.
** - surface



Cobalt concentration ranges and their distribution in Port Radium.



Uranium concentration ranges and their distribution in Port Radium.

Estimates of primary productivity.

LOCATION	NET CPM /REPLICATE SET*	AVERAGE PRODUCTIVITY $CO_2 m^{-2} h^{-1}$
Garbage Lake on July 1, 1983	1383, 1836, 1934, 2195	1278 nmol or 1.3 μmol
Great Bear Lake south of Cobalt Island on June 29, 1983	74, 199, 14, 236	36 nmol or 0.04 μmol
Great Bear Lake south of Cobalt Island on July 3, 1983	45, 79, 17, 51	14 nmol or 0.01 μmol

Elemental composition of tailings, overburden, and soil in $\mu g/g$.

SITE		pH	Cond.	Co	U	Dy	Ba	V	Cl
Garbage Lake:	n	6	6	4	17	2	2	6	1
	$\bar{x}$	8.1	150	88.7	161.1	2.3	3980	351.1	421
	sd	0.21	16	52.1	212.2	0.69	4247	226	–
	% error	–	–	17.4	6.9	21.0	11.2	12.3	22.5
Cobalt Channel:	n	6	6	3	6	1	4	2	6
	$\bar{x}$	8	105	159	130	0.33	5571	325	<153?
	sd	0.5	37.8	14	35	–	2995	112	578
	% error	–	–	13.7	6.9	25.3	22.4	16.3	–
Labine Bay:	n	7	7	6	7	7	7	7	2
	$\bar{x}$	7.5	145.7	101	224	0.21	1790	173	292
	sd	0.24	58.3	80	260	0.11	1110	107	73
	% error	–	–	8.6	1.4	15	16.2	8	29.4
Silver Point:	n	5	5	4	5	1	5	4	5
	$\bar{x}$	7.3	456	629	70	3.4	<3971	213	<1264
	sd	0.11	262	1015	35	–	2962	92	232
	% error	–	–	17	10.9	22.5	–	22.4	–
Murphy Lake:	n	13	13	10	11	6	9	11	6
	$\bar{x}$	6.9	1615	292	198	3.61	7514	374	680
	sd	1.36	3745	327	332	1.92	7191	110	929
	% error	–	–	10.8	5.2	10.3	20.3	10.6	21.43
Murphy Creek:	n	5	5	5	5	5	5	5	5
	$\bar{x}$	7.4	180	1127	1254	4.01	1925	502	<340
	sd	0.27	34	523	212	0.33	309	30	129
	% error	–	–	0.32	0.32	9.4	16.4	3.7	–
Murphy Bay:	n	2	2	2	2	2	1	2	2
	$\bar{x}$	8.0	160	1435	321	3.8	1099	392	326
	sd	0.78	28	906	223	2.04	–	51	30
	% error	–	–	0.6	0.6	5.9	14.8	2.3	18.6

Elemental composition of tailings, overburden. and soil in $\mu g/g$ cont'd.

SITE		pH	Cond.	Co	U	Dy	Ba	V	Cl
West Adit:	n	13	13	9	12	11	8	12	4
	$\bar{x}$	4.7	3202	120	1001	5.4	3450	449	249
	sd	1.61	3385	210	821	2.2	4646	185	60
	% error	–	–	7.9	1.5	7	16.3	3.4	22.9
Garbage Creek:	n	1	1	1	1	1	1	1	1
	$\bar{x}$	7.9	230	<42.0	21.5	0.18	2879	76.3	<656
	sd	–	–	–	–	–	–	–	–
	% error	–	–	–	11.1	29.5	16.3	27.3	–
Bear Creek:	n	2	2	1	2	2	2	2	2
	$\bar{x}$	7.1	955	168	<0.20	<0.20	3494	133	<883
	sd	0.28	206	–	0.05	0.05	4247	20	345
	% error	–	–	11.6	–	–	17.9	20.6	–
Parking Lot:	n	2	2	1	2	1	2	1	2
	$\bar{x}$	7.6	490	149	75.9	1.36	1609	162	<482
	sd	0.57	14	–	8.8	–	588	–	419
	% error	–	–	3.6	2.7	17.6	22.2	4.6	–
Bear Bay:	n	1	1	1	1	1	1	1	
	$\bar{x}$	8.2	110	36.7	9.6	0.10	1208	95.2	<330.1
	sd	–	–	–	–	–	–	–	–
	% error	–	–	11.8	8.3	13.9	11.5	8.1	–
Control soil:	n	1	1	1	1	1	1	1	1
	$\bar{x}$	3.1	1200	<13.4	2.7	0.045	741	103	<357
	sd	–	–	–	–	–	–	–	–
	% error	–	–	–	29	30.2	18.7	6.9	–

Elemental composition of tailings, overburden and soil in percent.							
SITE		L.O.I.	Mg	Na	Al	Mn	Ca
Garbagc Lake:	n	8	7	5	6	7	6
	$\bar{x}$	4.53	5.47	0.91	4.58	1.65	4.31
	sd	3.67	3.90	0.76	1.27	1.16	2.40
	% error	–	21.33	12.73	10.67	1.01	16.91
Cobalt Channel:	n	6	4	5	5	6	6
	$\bar{x}$	3.15	4.48	1.42	4.23	1.97	4.23
	sd	1.88	2.16	0.52	0.45	0.36	0.89
	% error	–	26.75	8.96	13.92	0.92	23.86
Labine Bay:	n	7	7	7	7	7	7
	$\bar{x}$	4.56	1.71	1.22	5.52	0.51	1.37
	sd	4.20	0.93	0.40	0.95	0.77	0.62
	% error	–	23.19	4.34	3.81	1.36	17.25
Silver Point:	n	5	3	5	4	5	5
	$\bar{x}$	1.52	3.68	1.44	4.53	1.90	4.91
	sd	0.52	0.19	0.24	1.03	0.45	0.61
	% error	–	22.82	8.17	14.10	0.82	18.39
Murphy Lake:	n	13	7	7	11	13	10
	$\bar{x}$	7.06	3.03	0.30	3.59	1.70	4.06
	sd	12.20	0.66	0.21	0.81	1.48	2.08
	% error	–	11.45	9.53	13.42	1.44	17.80
Murphy Creek:	n	5	5	5	5	5	5
	$\bar{x}$	0.94	5.33	0.26	5.22	0.18	2.99
	sd	0.58	1.20	0.04	0.87	0.03	0.53
	% error	–	7.14	10.96	3.34	1.67	12.96

Elemental composition of tailings, overburden and soil in percent cont'd.

SITE		L.O.I	Mg	Na	Al	Mn	Ca
West Adit	n	13	11	12	12	13	12
	$\bar{x}$	5.90	3.80	0.30	5.28	0.30	3.08
	sd	5.52	1.27	0.14	1.41	0.69	3.53
	% error	—	8.08	7.78	3.67	2.13	15.26
Garbage Creek	n	1	1	1	1	1	1
	$\bar{x}$	2.1	1.64	1.71	5.66	0.51	1.37
	sd	—	—	—	—	—	—
	% error	—	25.39	3.70	4.26	1.29	28.34
Bear Creek:	n	1	1	2	2	2	2
	$\bar{x}$	8.01	1.49	1.42	4.40	1.07	1.64
	sd	—	—	0.27	1.39	0.91	0.50
	% error	—	25.10	5.20	8.13	1.08	26
Parking Lot:	n	2	2	2	2	2	2
	$\bar{x}$	3.45	2.47	1.52	5.08	0.49	1.21
	sd	2.05	0.04	0.22	0.14	0.47	0.45
	% error	—	15.85	3.42	3.72	1.09	20.67
Bear Bay:	n	—	1	1	1	I	1
	$\bar{x}$	—	0.67	1.71	6.03	0.07	1.14
	sd	—	—	—	—	—	—
	% error	—	12.71	1.37	2.67	1.76	14.02
Control Soil:	n	1	1	1	1	1	1
	$\bar{x}$	11.6	1.85	2.63	4.72	0.04	<0.36
	sd	—	—	—	—	—	—
	% error	—	8.26	1.02	3.10	2.22	—

Sediments around the Port Radium Peninsula.

ELEMENT & QUALITY		INNER LABINE BAY		OUTER LABINE BAY		COBALT CHANNEL		MURPHY BAY	
		EPS	KALIN	EPS	KALIN	EPS	KALIN	EPS	KALIN
U $\mu g/g$	n	1	1	2	1	5	6	1	1
	$\bar{x}$	na	48	910	270	700	443	na	163
	sd	na	0	693	0.6	898	498	na	0
	% error	–	1.7	–	0.6	–	3.6	–	0.8
Co $\mu g/g$	n	1	1	2	1	5	3	1	1
	$\bar{x}$	69	58	571	224	282	171	452	794
	sd	0	0	216	0	282	7.7	0	0
	% error	–	7.7	–	3.3	–	11.4	–	0.8
	DL	–	–	–	–	–	< 242		
		–	–	–	–	–	< 76		
		–	–	–	–	–	< 82		
Ba $\mu g/g$	n	1	1	2	1	5	6	1	1
	$\bar{x}$	846	114	880	1349	1089	4816	696	–
	sd	0	0	124.5	0	206.4	2633.5	0	–
	% error	–	11.3	–	14.5	–	23.1	–	–
	DL	–	–	–	–	–	–	–	<544
Mg $\mu g/g$	n	1	1	2	1	5	5	1	1
	$\bar{x}$	14700	16203	23400	13328	21680	12261	25800	23629
	sd	0	0	7071.1	0	5965.5	5001	0	0
	% error	–	7.9	–	11.1	–	25.2	–	6.48
	DL	–	–	–	–	–	< 71879.4	–	–
Na $\mu g/g$	n	1	1	2	1	5	6	1	1
	$\bar{x}$	10800	12023	7100	13328	698	11399	3800	2087
	sd	0	0	3252.7	0	3389.2	0	0	0
	% error	–	1.8	–	11.1	–	10.2	–	5.8
V $\mu g/g$	n	1	1	2	1	5	4	1	1
	$\bar{x}$	104	109	268	179	222	321	332	356
	sd	0	0	128.7	0	108.3	78.0	0	0
	% error	–	5.3	–	5.9	–	13.9	–	2.1
	DL	–	–	–	–	–	< 180.0	–	–
		–	–	–	–	–	< 321.8	–	–
Al $\mu g/g$	n	1	1	2	1	5	6	1	1
	$\bar{x}$	68100	63953	52500	51492	60480	43741	50400	40713
	sd	0	0	240.4	0	13854	6244.8	0	0
	% error	–	1.5	–	1.8	–	11.3	–	2.8
Mn $\mu g/g$	n	1	1	2	1	5	6	1	1
	$\bar{x}$	702	504	2995	2105	13841	17786	5070	921
	sd	0	0	1067.7	0	13062.8	4757.4	0	0
	% error	–	2.1	–	1.0	–	0.8	–	1.4
Ca $\mu g/g$	n	1	1	2	1	5	6	1	1
	$\bar{x}$	9080	7764	15800	13745	38218	35650	14800	12624
	sd	0	15.7	0	0	29431.1	13507.4	0	0
	% error	–	15.7	4525.5	13.0	–	23.9	–	12.6
L.O.I	n	1	1	2	1	5	6	1	1
	%	11.5	10.6	3.6	3.9	4.0	31	0.8	0.3
	sd	–	–	0.1	–	1.3	1.9	–	–

n = No. of samples with conc. $\bar{x}$ = mean of conc.
sd = variance of conc. mean % error = mean of errors of NAA Kalin.
DL = samples of Kalin (NAA) which were less than detection limit in $\mu g/g$.

Water quality in outer Labine Bay station 38-4 (1969 - 1982).

ELEMENT & QUALITY	REDSHAW[1] JUNE 1969	JUNE - AUGUST 1970	JANUARY & JUNE 1971	JULY 1972	MAY - NOVEMBER [3] 1973	JANUARY 1974	KALIN[2] JULY 1982
No. of samples	n = 1	n = 4	n = 2	n = 1	n = 6	n = 1	n —3
pH	7.6	7.9±0.1	7.9±0.1	6.6	7.920.1	8.6	7.5±0.0
Cond.[4]	181	15524.5	**167**± 2.5	nr	155± 5.3	155	100±0.0
	mg/l	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**
Ca	17.2	16.2'	16.9± 1	17.5	**16.3± 1.6*****	16.0	16.7± 1.1
As	0.022	0.00520.007**	0.02*	< 0.004	< 0.01	< 0.004	0.13±0.13
Cu	< 0.01	0.01±0.01	0.16±0.21	< 0.001	< 0.015	0.055	0.00±0.00
Fe	0.19	**0.11±0.03****	0.07±0.04	nr	0.03±0.05	0.61	0.01±0.01
Pb	nr	nr	0.016'	< 0.004	0.01±0.01	0.004	0.03±0.02
Ni	nr	nr	nr	nr	< 0.03	0.004	0.00±0.00
Zn	nr	nr	0.025'	< 0.01	0.002k0.002	0.009	0.00±0.00
Co	nr	nr	nr	0.004	< 0.02	0.001	0.02±0.01 ±0.01

[1]Redshaw (1974): sample station 38-4.
[2]**Kalin** : ICP analyses for sample stations 5W-1, 2, 3, & 4.
[3]**May-November: with** the exception of September.
[4]**Cond.: μmhos/cm.**
*n = 1
**n = 2
***n = 3
nr = no results

Cobalt Channel water characteristics (1969 - 1982).

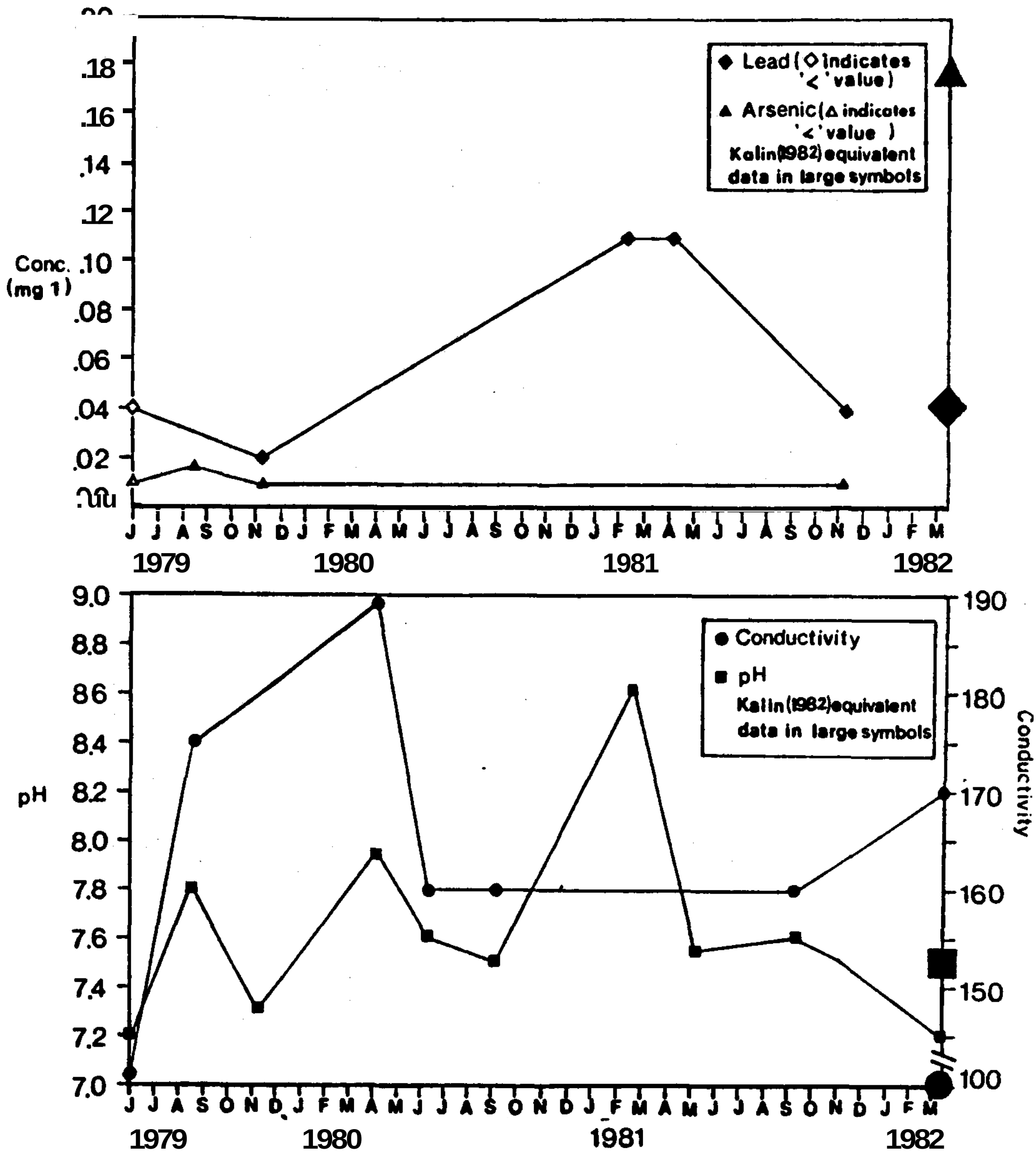
ELEMENT & QUALITY	REDSHAW[1] JUNE 1969	JUNE 1971	JULY-JAN.[4] 1973	JAN. 1974	SUTHERLAND[2] JULY-AUG. 1978	KALIN[3] JULY 1982
No. of samples	n = 1	n = 1	n = 6	n = 1	n = 2	n = 4
pH	7.7	7.5	7.75 ± 0.14	8.0	nr	8.3 ± 0.08
Cond.[5]	167	163	160.5 ± 10.1	200	170 ± 0	145 ± 28.9
	mg/l	mg/l		mg/l	mg/l	mg/l
Ca	15.6	16.2	18 ± 0*	20	11**	17 ± 0.48
As	0.002	0.02	0.02 ± 0.03	< 0.004	< 0.005	0.03 ± 0.06
Cu	0.01	C 0.001	0.0033 ± 0.0004	< 0.001	< 0.02	0 ± 0
Fe	0.08	0.05	0.11 ± 0.14	< 0.02	0.02 ± 0.02	0.11 ± 0.19
Pb	–	C 0.003	0.01 ± 0.01	0.005	< 0.005	0.05 ± 0.05
Ni	–	–	0.01 ± 0.01	0.003	< 0.03	0.01 ± 0.01
Zn	–	0.002	0.0048 ± 0.01	0.007	< 0.01	0.01 ± 0.02
Co	–	–	0.0013 ± 0.0016	< 0.001	< 0.05	0 ± 0

[1]Redshaw (1974): samples for 1969, 1971, 1974 at site (38-6), 1973 (38-5,6).
[2]Sutherland (p.c.): samples for 1978 at site 11.
[3]Kalin: ICP analyses for sample stations 2W-1, 2, 3, & 4.
[4]July-Jan.: with the exception of Sept., Nov. & Dec. 1973
[5]Cond.: µmhos/cm
*n = 3
**n = 1
nr = not reported.

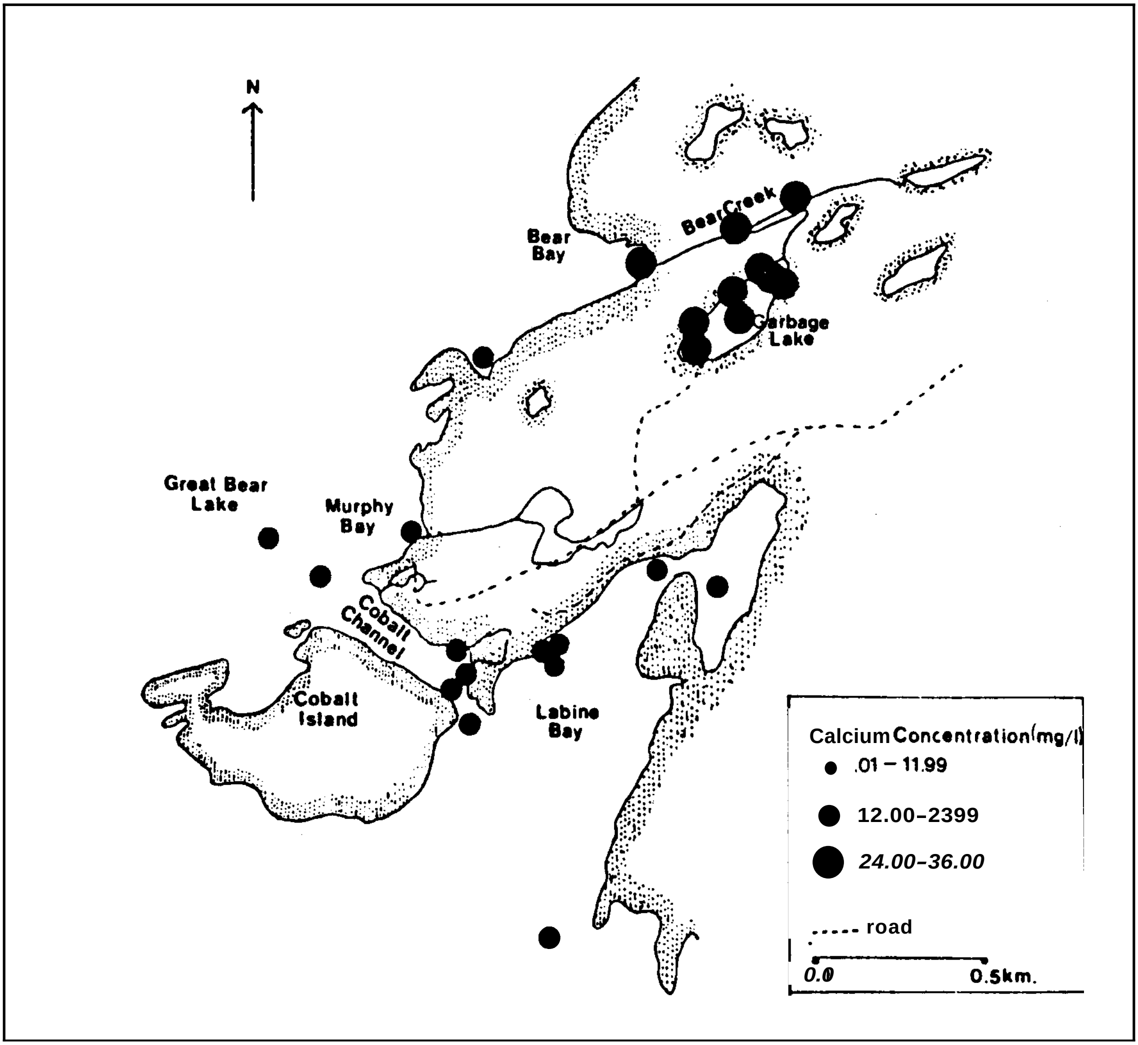
Characteristics of effluents from Garbage Lake (1973 & 1982).

ELEMENT & QUALITY	WILSON[1] MAY 1978 V-notch	REDSHAW[2] MAY-AUG. 1973 GARBAGE LAKE	KALIN JULY 1982 GARBAGE LAKE	JULY 1982 V-notch
No. of samples	n = 22	n = 4	n = 7	n = 1
pH	7.52±0.24	7.4820.15	8.21±0.13	7.2
Cond.[3]	603±742	377±79	345±5	110
	mg/l	mg/l	mg/l	mg/l
Ca	42.93±13.79*	29.20±10.75**	34.76±1.32	23.01
As	2920.31	0.01±0.004	0.050±0.010	0.008
Cu	0.02±0.01	0.0220.003	0.00±0.0	0.00
Fe	0.9621.12***	0.63±0.14	0.01±0.01	0.02
Pb	< 0.05	0.0120.01	0.04±0.03	0.04
Ni	0.23±0.09	0.02±0.02	0.06±0.01	0.02
Zn	0.03±0.02	0.29±0.05	0.003±0.004	0.00
Cd	< 0.01	nr	0.0±0.0	0.0
Mg	13.03±4.43****	nr	14.95±0.26	8.06

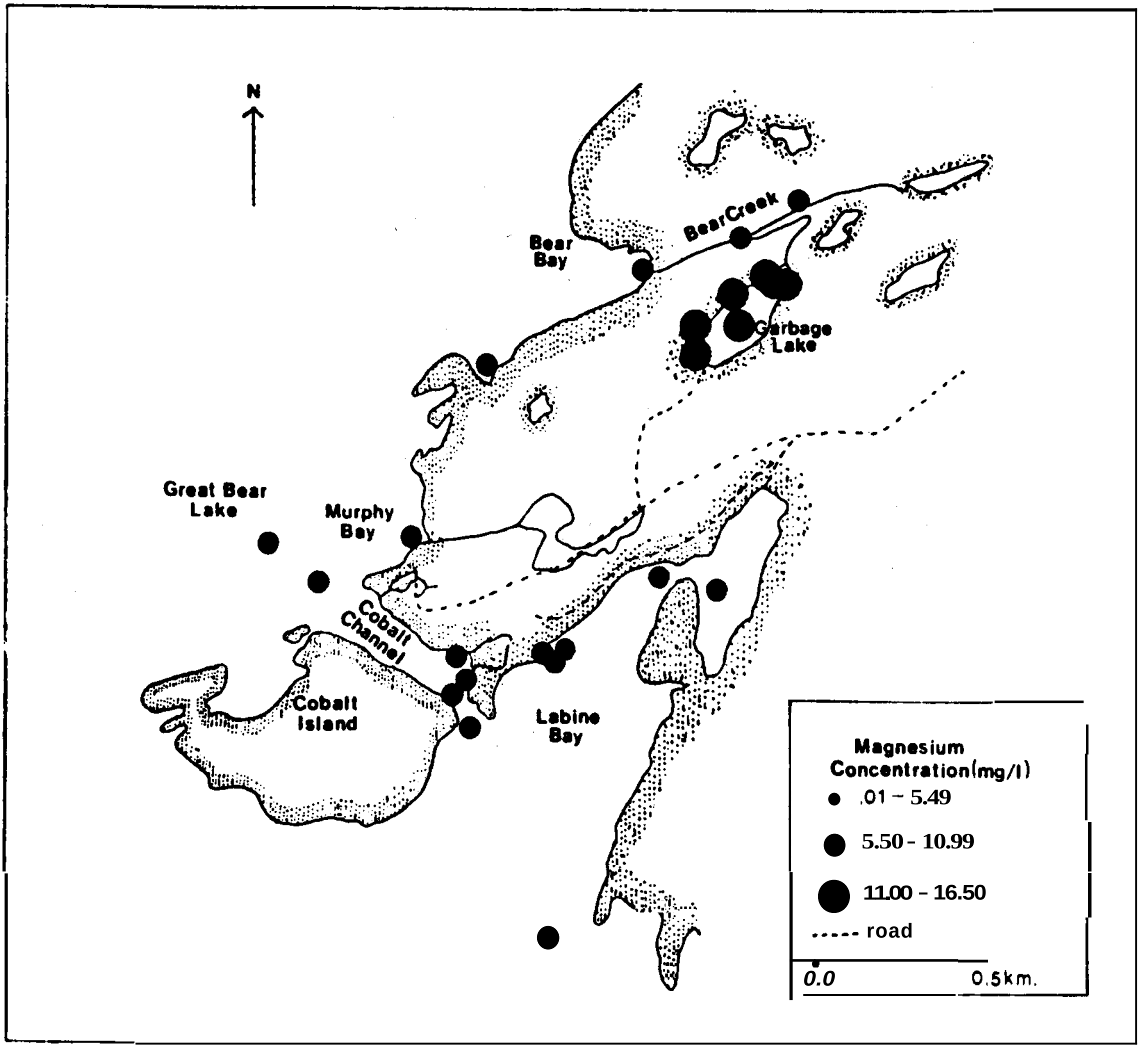
[1]Wilson (1978).
[2]Redshaw (1974).
[3]Cond.: µhos/cm.
*n = 13
**n = 2
***n = 18
****n = 12



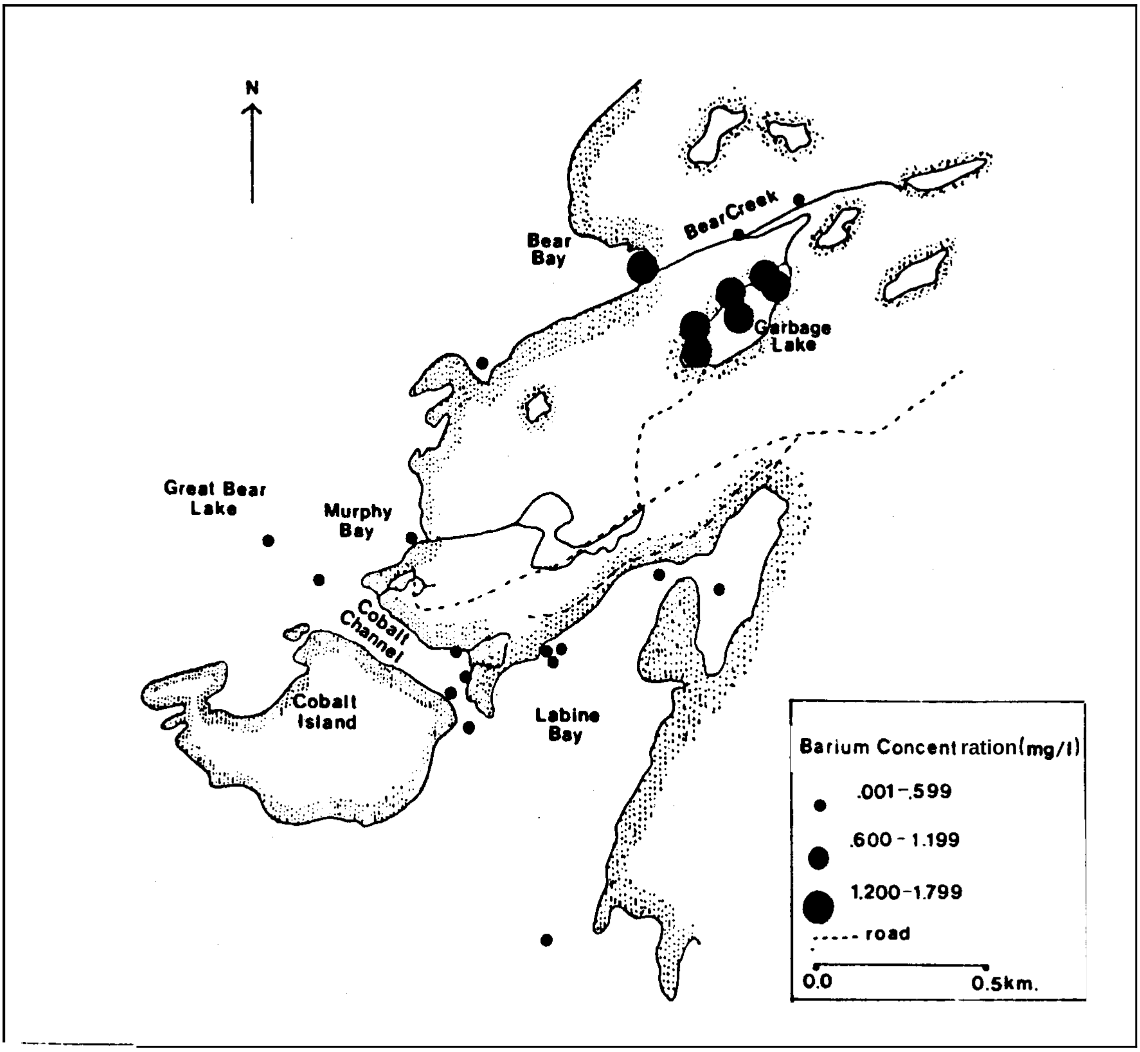
Lead and arsenic concentrations along with pH and electrical conductivity for station 38-4 in the outer Labine Bay (1979-1982). Seasonal changes in these parameters are **suggested.**



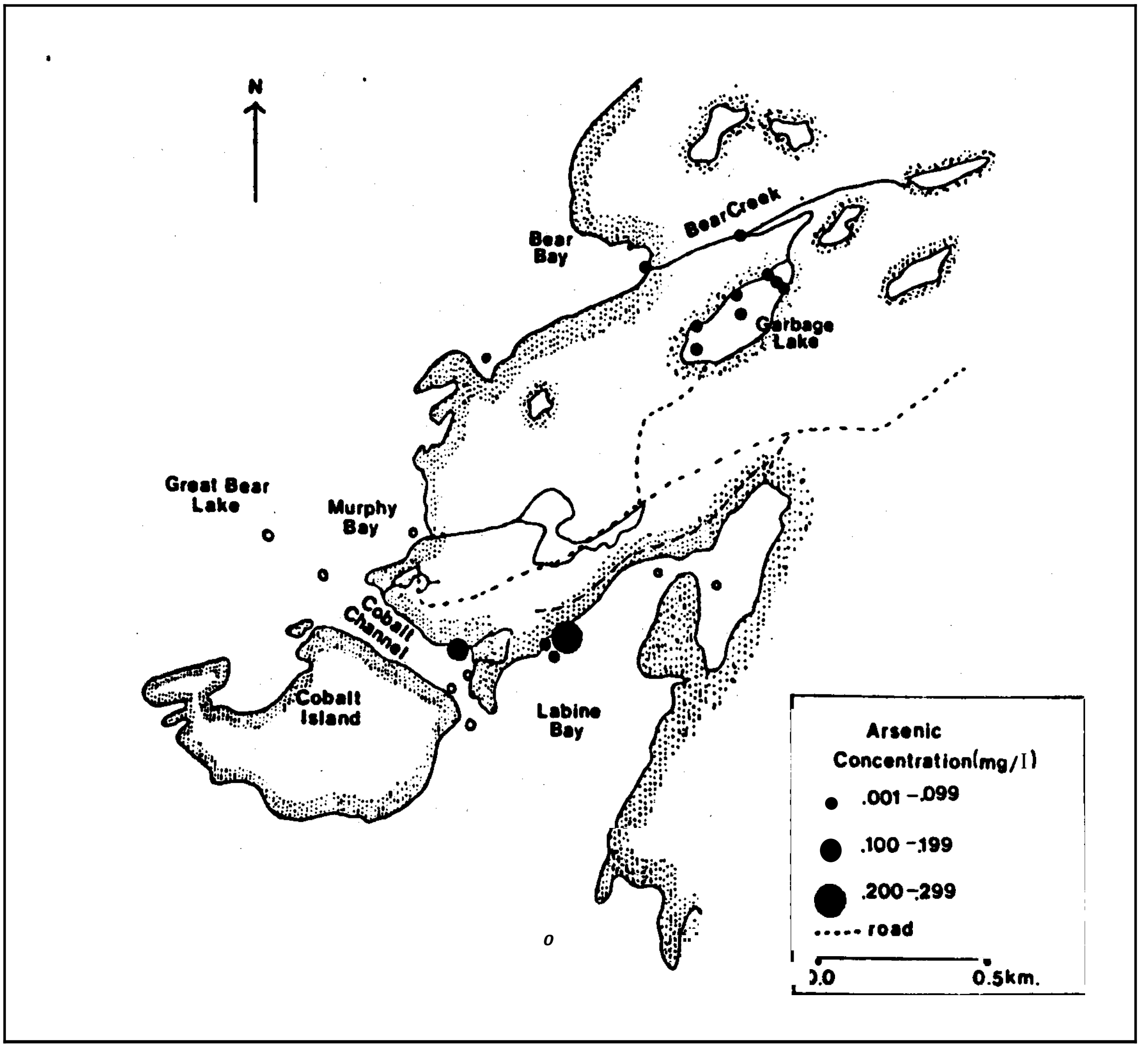
Concentrations of calcium in water samples in the Port Radium vicinity. Calcium concentrations ranged from **15.76** to **35.47** mg/l. Great Bear Lake has an average calcium concentration of **16** mg/l (Johnson, **1975**).



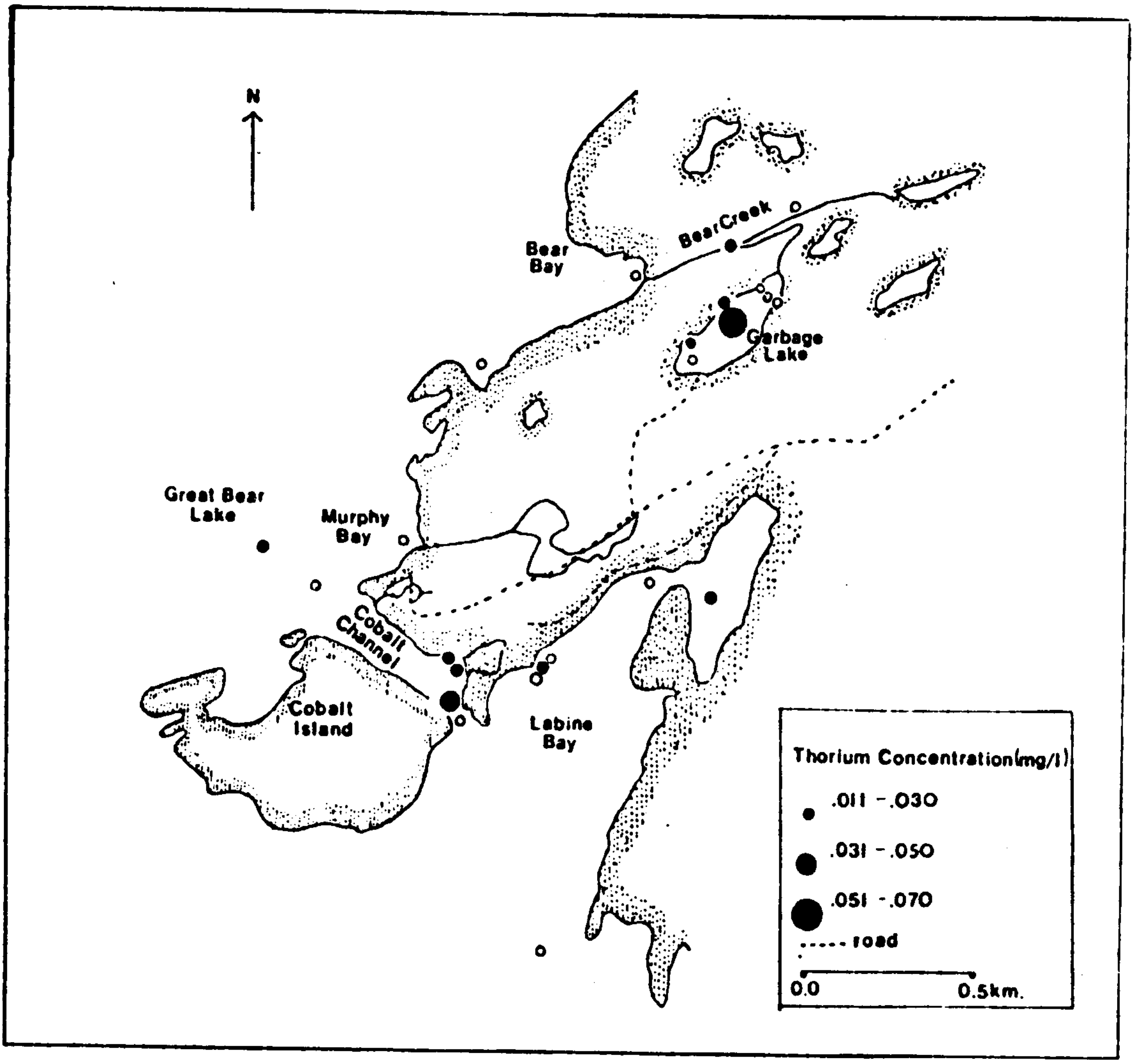
Concentrations of magnesium in water samples in the Port Radium vicinity. Magnesium concentrations ranged from 7.21 to 15.31 mg/l. Great Bear Lake has an average concentration of 6.7 mg/l (Johnson, 1975).



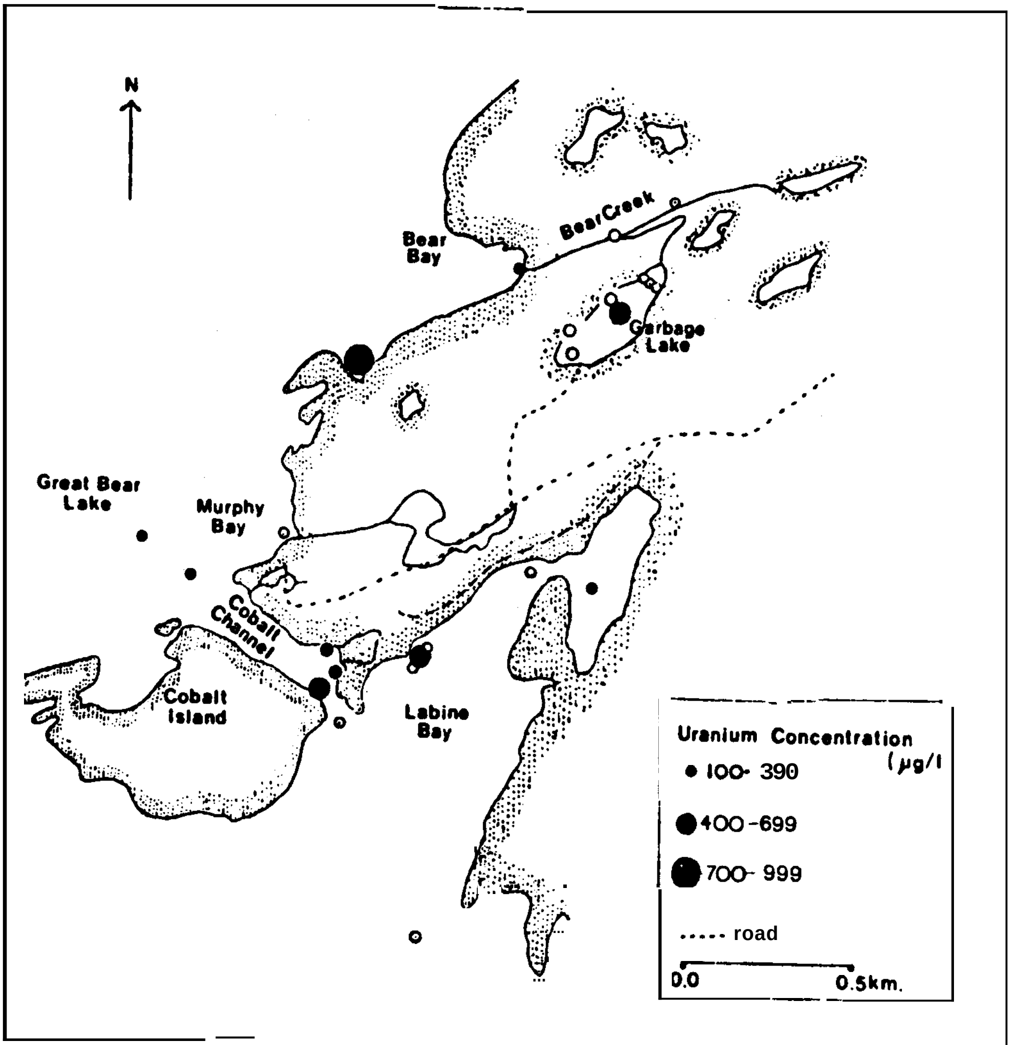
Concentrations of barium in water samples in the Port Radium vicinity. The concentrations ranged from 0.030 **to 1.67** mg/l. Freshwater concentrations for barium are given by Bowen **(1966)** as **0.054** mg/l.



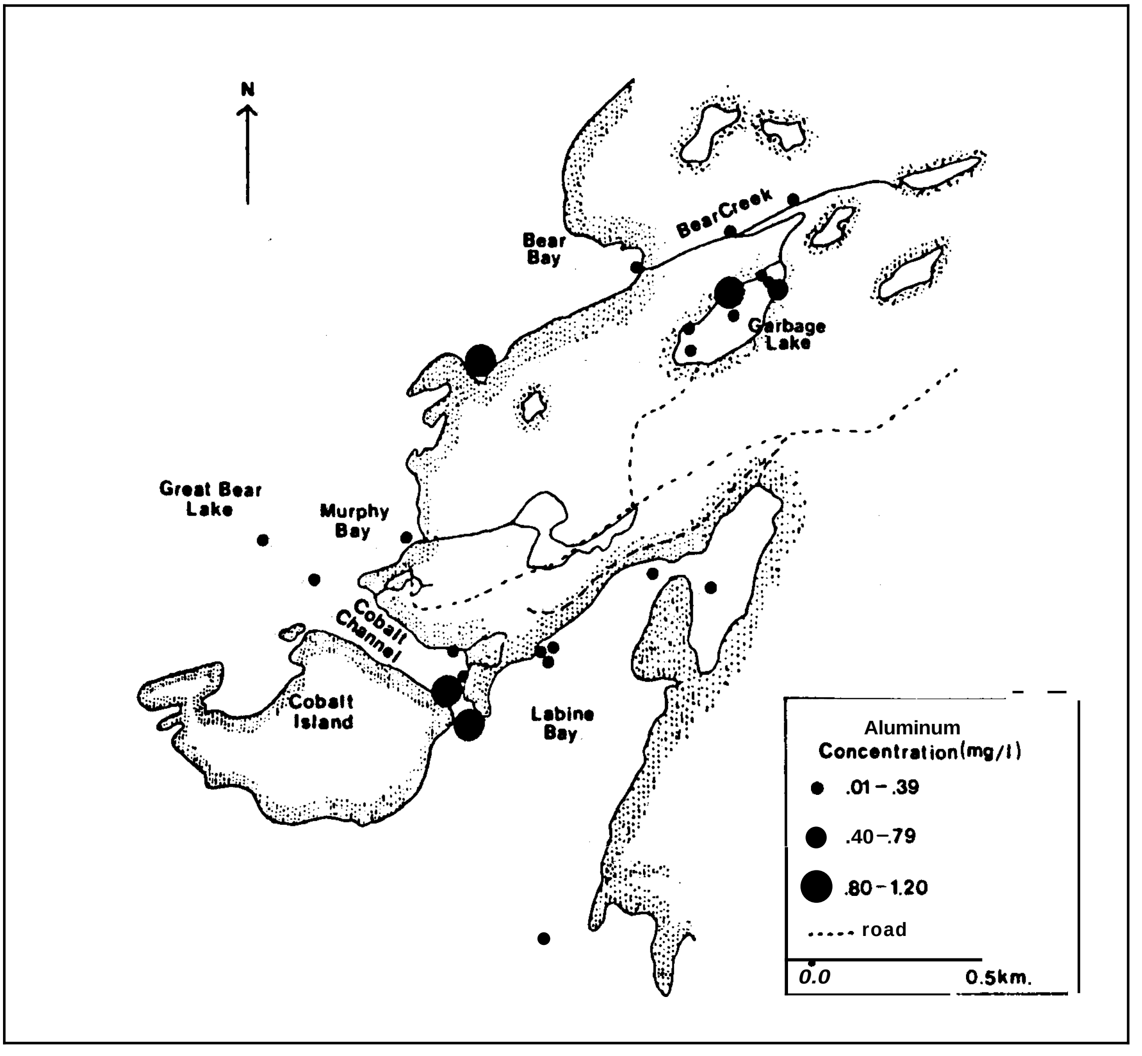
Concentrations of arsenic in water samples in the Port Radium vicinity. Arsenic concentrations ranged from 0.0000 to 0.280 mg/l. Freshwater average background concentrations are between 0.002 to 0.01 mg/l (Allen, 1974). Open circles are less than the detection limit of 0.002 mg/l for ICP or values of 0.0000 mg/l.



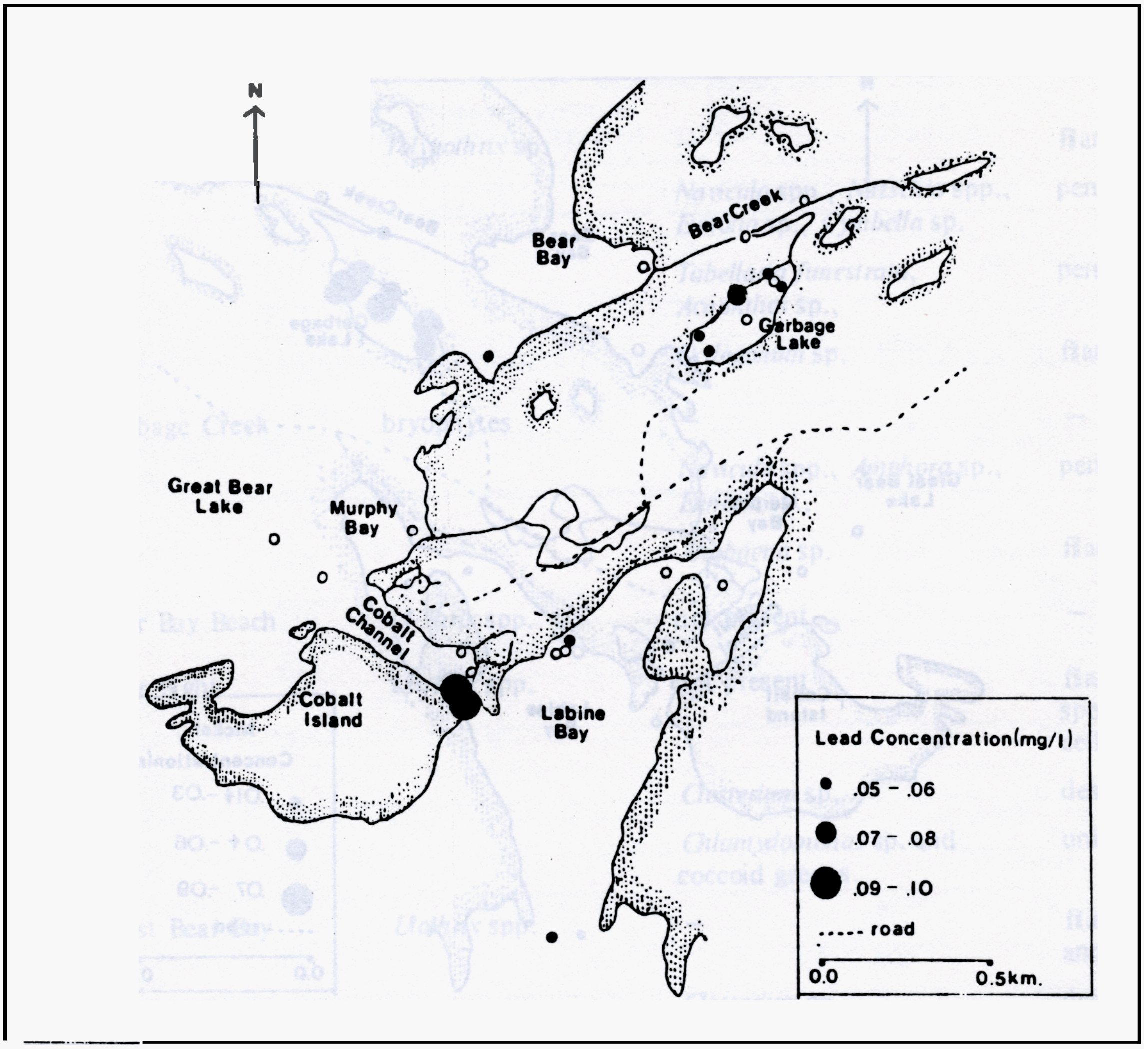
Concentrations of thorium in water samples in the Port Radium vicinity. Thorium concentrations ranged from 0.01 *to* 0.07 mg/l. Background concentrations in freshwater are reported to be less than 0.00002 mg/l (Bowen, 1966). Open circles are less than the detection limit of 0.011 mg/l in ICP analyses.



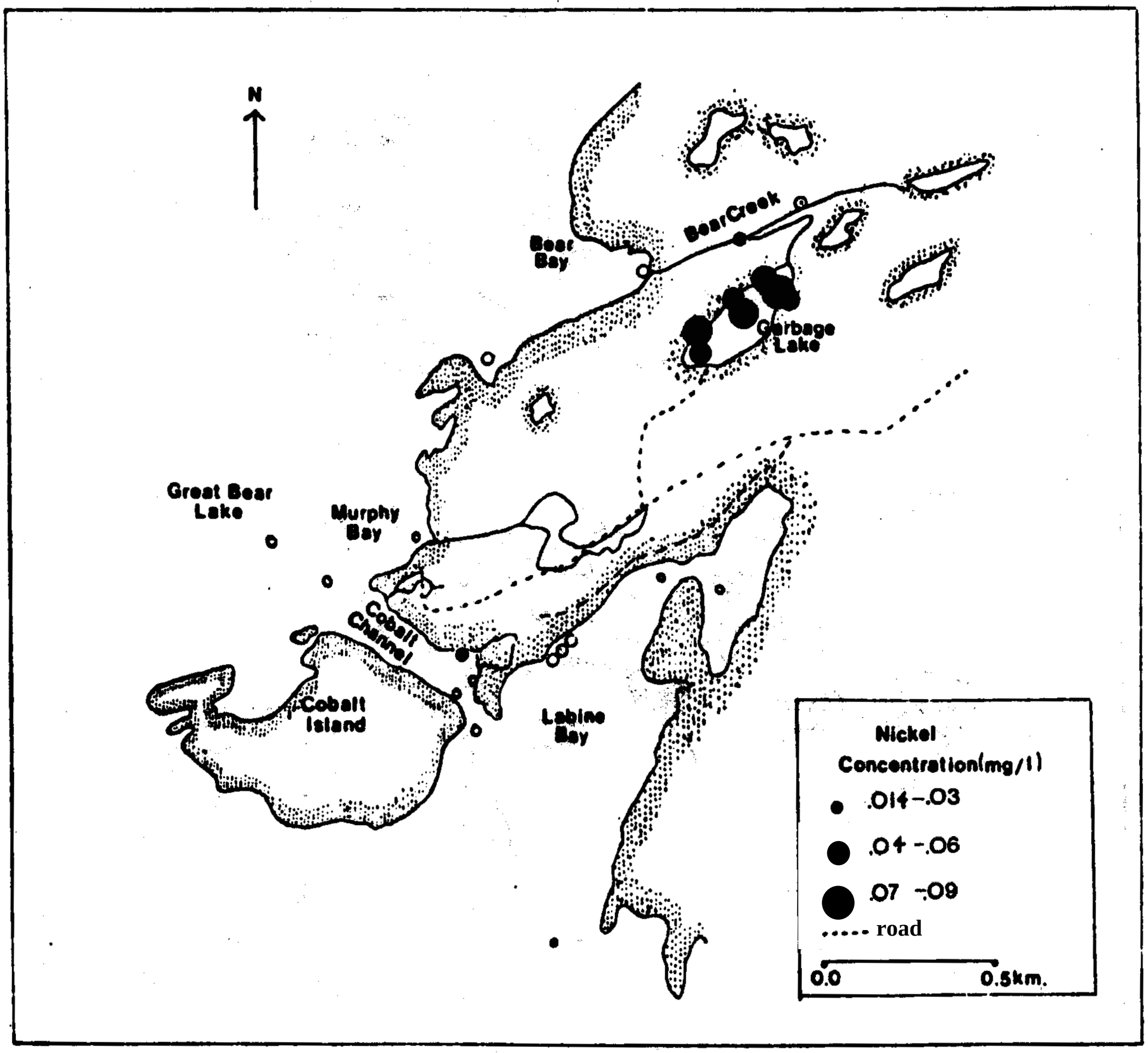
Concentrations of uranium in water samples in the Port Radium vicinity. Concentrations ranged from 100 **to 941 µg/l.** Open circles are values **below** the detection limit of 100 µg/l or values of 100 µ. Canadian Shield Lakes ranged in uranium concentrations from 0.001 **to 170** µg/l with a median value of 0.05 µg/l (Environment Canada, in press).



Concentrations of aluminum in water in the Port Radium vicinity. Aluminum concentrations ranged from 0.06 to 1.10 mg/l. Background concentrations of aluminum in Canadian freshwater are reported to be less than 1 mg/l (Environment Canada, 1979).



Concentrations of lead in water in tbe Port Radium vicinity. Concentrations of lead ranged from 0.05 to 0.09 mg/l. Open circles are below detection limit of 0.05 mg/l. Background concentrations of lead in freshwater are reported as 0.005 mg/l (Environment Canada, 1979).



Nickel concentrations in waters in the vicinity of Port Radium. The concentration ranges of nickel are 0.02 to 0.08 mg/l. Natural background concentrations for freshwater are reported by Environment Canada (1979), as 0.1 mg/l. Open circles are at the detection limit of ICP of 0.014 mg/l or values lower than of 0.0000 mg/l.

Identification of algal samples in **Port Radium, NWT.**

LOCATION	DOMINANT	MINOR COMPONENT	DESCRIPTION
Bear Creek Upstream	*Tolypothrix* sp.	—	filamentous blue-green
		Navicula spp., *Nitzschia* spp., *Eunotia* sp., *Cymbella* sp.	pennate diatoms
		Tabellaria fenestrata, *Achnanthes* sp.,	pennate diatoms
		Oedogonium sp.	filamentous green
Garbage Creek	bryophytes	—	—
		Navicula spp., *Amphora* sp., *Eunotia* sp.,	pennate diatoms
		Anabaena sp.	filamentous blue-green
Bear Bay Beach	*Ulothrix* spp.	not present	—
Bear Bight	*Ulothrix* spp.	not present	filamentous green, two species : large and small cells.
		Closterium sp.	desmid
		Chlamydomonas sp. and coccoid greens.	unicellular greens.
West Bear Bay	*Ulothrix* spp.	—	filamentous green, large and small cells.
		Closterium sp.	desmid.
		Navicula spp., *Amphora* sp.	pennate diatoms
Control Bay	*Ulothrix* spp.	—	filamentous green ,large and small cells.
		Pinnularia sp., *Navicula* sp.	pennate diatom
		Uronema sp.	filamentous green
Cobalt Channel (tailings beach)	*Ulothrix* spp.	—	filamentous green, two species : large and small cells.
		Navicula spp.	pennate diatoms
		Oscillatoria sp.	filamentous blue-green

Major terrestrial plants associated with waste material in Port Radium.

FAMILY & SPECIES	OUTSIDE LAB	CROSS FAULT LAKE			MURPHY CREEK	WEST ADIT	CONTROL BAY	RANGE	HABITAT
	WRO	SWR	SHO	OWR		TLS			
LICHENS									
Cetraria cucullata (Bell.) Ach.				X			X	AAA	In meadows and among rocks.
Cetraria nivalis (L.) Ach.							X	AAA	In meadows and among rpcks.
Cladonia cf. *pyxidata* (L.) Hoffm.				X				ATM	On humus and soil over rocks in open areas.
Cladonia spp.				X					
Stereocaulon cf. *tomentosum* Fr.							X	ATM	On soil over rocks and on humus.
BRYOPHYTES									
Aulacominium turgidum (Whal.) Schwaegr		X						ASA	Moist mossy areas.
Dicranum cf. *majus* Sm.							X	ABO	Rocky scree slopes.
cf. *Dicranella* spp.				X					
Bryum cf. *capillare* Hedw.					X			COS	
Indeterminate Bryaceae cf. *Pohlia*						X	X		
Bryum argenteum Hedw.						X		COS	Most prevalent on rocks at high elevations in Arctic and Antarctic.
Thuidium abietinum (Brid.) B.S.G.							X	ATM	On soil and rocks. usually calcareous
Ptilidium ciliare (L.) Hampe				X				ATM	On soil over rocks.
EQUISITACEAE									
Equisetum arvense L.		X			X			ATM	Habitat and soils variable; weed.
Equisetum hyemale L.			X					BOT	Sandy soils and woods.
Equisetum scorpiodes L.						X		BOT	Conifer woods. tundra. heaths, swamps.
CYPERACEAE									
Carex aquatilis Wahlenbb. ssp. *aquatilis*			X					ABO	Shallow water, marshes, along rivers.
Eriophorum cf. *angustifolium* Honck.			X					ATM	Wet bogs and shores.

AAA = arctic and arctic alpine
ASA = arctic and sub-arctic
COS = cosmopolitan
WRO = waste rock and overburden
SHO = shores
TLS = tailings
ATM = arctic and temperate
ABO = arctic and boreal
BOT = boreal and temperate
SWR = side of waste rock
OWR = waste rock

Major terrestrial plants associated with waste material in Port Radium cont'd.

FAMILY & SPECIES	OUTSIDE LAB	CROSS FAULT LAKE			MURPHY CHEEK	WEST ADIT	CONTROL BAY	RANGE	HABITAT
	WRO	SWH	SHO	OH'R		TLS			
ERICACEA									
Pyrola asarifolia Michx. v. *purpurea* (Bunge) Fern.							X	BOT	Woods, meadows.
Ledum groenlandicum Oeder							X	ATM	Heaths, dry rocky places.
EMPETRACEAE									
Empetrum nigrum L.						X		ARC	Heaths, bogs.
Arctostaphylos uva-ursi (L.) Spreng.						X		ABO	Dry sandy places.
ONAGRACEAE									
Epilobium angustifolium L.		X						ATM	Meadows, forests, river bars, burnt areas.
Epilobium latifolium RL.							X	ABO	River bars, along streams, scree slopes.
CRUCIFERAE									
Descureana cf. sophoides (Fisch) Schutz		X						BGA	Gravel bars, disturbed soil.
Arabis alpina L.	X								
Arabis hirsuta (L.) Scop var. *pycnocarpa* (Hopk.) Hult.	X							ATM	Dry rocky places.
Rorippa hispida (Desv.) Britt.	X							BOT	Waste places open soil.
LEGUMINOSAE									
Oxytropis varians (Rydb.) Hult.	X				X			AMT	Dry sandy places.
Hedysarum alpinum v. americanum					X		X	BOR	Rocky slopes, spruce forests, gravel bars.
SAXIFRAGACEAE									
Saxifraga tricuspidata							X	ABA	Dry, sandy places; rock crevaces, ridges.
PRIMULACEAE									
Androsace septentrionalis L.	X							ABO	Dry rocky, sandy places in mountains.
COMPOSITAE									
Aster cf. sibericus L.					X			BAB	Stony slopes, river flats, meadows.

BOT = boreal and temperate
ARC = arctic
BGA = Beringian arctic
BOR = boreal
ABA = arctic. boreal, North America
H'RO = waste rock and overburden
SHO = shores

ATM = arctic and temperate
ABO = arctic and boreal
AMT = arctic and mountain
BAB = Beringian arctic and boreal
TLS = tailings
SWR = side of waste rock
OWR = waste rock

Major terrestrial plants associated with waste material in Port Radium cont'd.

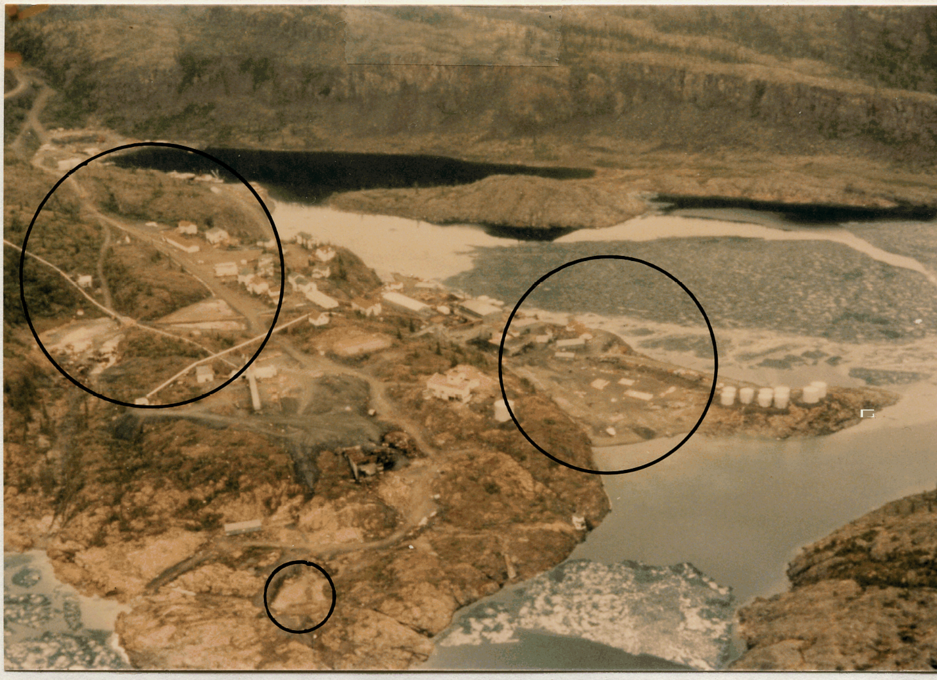
FAMILY & SPECIES	OUTSIDE LAB	CROSS FAULT LAKE			MURPHY CREEK	WEST ADIT	CONTROL BAY	RANGE	HABITAT
	WRO	SWR	SHO	OWR		TLS			
GRAMINEAE									
cf. Agropyron viplaceum (Hornem) Lang.							X	ABO	Sandy gravelly river bars
cf. Calamagrostis canadensis (Michx.) Beauv.		X				X		BOT	Meadows, wet places; common.
cf. Calamagrostis neglecta (Ehrh.) Gaetn.		X						BOT	Shores, wet places; variable.
Poa cf. alpigena (E. Fries) Lindm.	X				X		X	ABO	Grassy, slopes, gravel bars (variation of *P. praetensis*).
Poa cf. praetensis L.				X		X		BOT	Waste places, roadsides, yards; weed.
PINACEAE									
Picea glauca Moench.					X			BNT	Forest tree.
Juniperus horizontalis					X			BNT	Rocky and sandy places
SALICACEAE									
Salix bebbiana Sarg.					X	X	X	ROT	Moist or wet places.
Salix cf. lanata L. spp. *richardsonii* (Hook) Skrorte.						X		ARC	Wet places, heaths, riverbanks.
Salix cf. athabascensis Raup.		X						WBA	Pool margins, treed bogs.
BETULACEAE									
Betula glandulifera (*B. glandulosa* Michx.)					X	X		ANA	Wet places, swamps, bags:
Betula papyrifera				X	X			BOT	Forest tree to shrub.
ELEAGNACEAE									
Shepherdia canadensis (L.) Nutt.					X			NBT	Woods, gravel bars.
ROSACEAE									
Potentilla fruticosa L.					X			NBT	Wet and dry ground: forests, heaths, muskeg, scree.
Rosa *acicularis* Lindl.					X			BOT	Woods, heaths, bogs, thickets.

ABO = arctic and boreal
BNT = boreal and northern temperate
WBA = west boreal, North America
ANA = arctic, northern temperate, North America
WRO = waste rock and overburden
SHO = shores
BOT = boreal and temperate
ARC = arctic
NBT = northern boreal and temperate
TLS = tailings
SWR = side of waste rock
OWK = waste rock

APPENDIX D

Plate:

1. PORT RADIUM: View northeast.
2. View southeast showing Garbage Lake(light green).
3. Silver Point tailings area.
4. West Adit tailings area.



1. **PORT RADIUM: View northeast. Clockwise from upper left: Radium and Murphy Lakes, Silver Point tailings area, and West Adit tailings area.**

2. View southeast showing Garbage Lake (light green).

3. Silver Point tailings area.

4. West Adit tailings area.